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SERIALS

The following list gives in full the abbreviated citations used after the titles of papers in this issue of GeoScience Abstracts.

Akademiya Nauk SSSR, Proceedings [Doklady], Geochemistry Section, in English translation (Consultants Bureau). New York.
American Association of Petroleum Geologists, Bulletin. Tulsa, Oklahoma.
American Ceramic Society, Journal. Easton, Pennsylvania.
Association of American Geographers, Annals. Lawrence, Kansas.
California, Division of Mines, [Map]; Mineral Information Service. San Francisco.
California, University, Publications in Geography; Publications in Geological Sciences. Berkeley and Los Angeles.
Canada, Dominion Observatory, Publication. Ottawa.
Canada, Geological Survey, Bulletin; Map; Paper. Ottawa.
Canadian Geographer (Canadian Association of Geographers). Ottawa.
Economic Geology (Society of Economic Geologists). Lancaster, Pennsylvania.
Geological Society of America, Bulletin. New York.
Harvard Foundation for Advanced Study and Research, Newsletter. Cambridge, Massachusetts.
IGY World Data Center A: Glaciology, IGY Glaciological Report Series (American Geographical Society). New York.
Illinois State Geological Survey, Circular; Educational Series. Urbana, Illinois.
Indiana, Geological Survey, Bulletin; Circular; Report of Progress. Bloomington, Indiana.
International Geology Review (American Geological Institute). Washington, D. C.
Journal of Geology. Chicago.
Journal of Geophysical Research. Washington, D. C.
Journal of Marine Research. New Haven, Connecticut.
Journal of Petroleum Technology (Society of Petroleum Engineers). Dallas, Texas.
Journal of Sedimentary Petrology. Tulsa, Oklahoma.
Journal of Soil and Water Conservation (Soil Conservation Society of America). Des Moines, Iowa.
Kentucky Geological Survey, [Map]. Lexington, Kentucky.
Keystone Newsletter (Mineralogical Society of Pennsylvania). Philadelphia.
Micropaleontology (American Museum of Natural History). New York.
Minnesota Geological Survey, Bulletin. Minneapolis, Minnesota.
National Academy of Sciences-National Research Council, Publication. Washington, D. C.
Naval Research Reviews (U. S. Office of Naval Research). Washington, D. C.
North Dakota Geological Survey, Ground-Water Studies. Grand Forks, North Dakota.
Ohio, Division of Water, Ohio Water Plan Inventory, Report. Columbus, Ohio.
Oregon, Dept. of Geology and Mineral Industries, Bulletin; Miscellaneous Paper. Portland, Oregon.
Pennsylvania Geological Survey, Information Circular. Harrisburg, Pennsylvania.
Pennsylvania State University, College of Mineral Industries, Contribution. University Park, Pennsylvania.
Professional Geographer (Association of American Geographers). Washington, D. C.
Rock Products. Chicago.
Science. Washington, D. C.
Scientific American. New York.
South Carolina, State Development Board, Division of Geology, Bulletin; Geologic Notes. Columbia, South Carolina.
Texas, University, Bureau of Economic Geology, Geologic Quadrangle Map; Report of Investigations. Austin, Texas.
U. S. Atomic Energy Commission, Knolls Atomic Power Laboratory, [Publication]. Albany, New York.
U. S. Geological Survey, Bulletin; Mineral Investigations Map; Miscellaneous Investigations Map; Oil and Gas Investigations Map; Professional Paper; Water-Supply Paper. Washington, D. C.
Utah, Agricultural Experiment Station, Special Report. Logan, Utah.
Washington, University, Dept. of Oceanography, Contribution. Seattle, Washington.

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Those wishing to purchase items abstracted herein should address their orders to the agency, society, or organization indicated in the bibliographic citations preceding the abstracts, or to their local book dealer. The city and state for the serials cited are given above. The American Geological Institute, publisher of GeoScience Abstracts, regrets that it cannot fill purchase orders for abstracted publications other than its own.

GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

1-2404. Norris, D.K. CARBONDALE RIVER, ALBERTA AND BRITISH COLUMBIA: Canada, Geol. Survey, Map 5-1959, scale 1:63,360, 2 secs, marginal notes, 1959.

Map covers 194 sq. mi. on the E. side of the Rocky Mountains. The Lewis thrust crosses the area and divides it into subequal structural regions, N. of the surface trace of the thrust is the disturbed belt, S. of it the Rocky Mountains. The disturbed belt consists mainly of Cretaceous strata, folded, faulted, and in places overturned. A small area of late Paleozoic rocks occurs on the nose of Turtle Mountain anticline, and there are some small areas of Jurassic rocks.

The southern half of the area (Rocky Mountains) is part of the Lewis thrust sheet and consists mainly of Precambrian rocks in broad open folds. Several minor thrust faults occur near the front of the main sheet, and multiple, high angle, W.-dipping faults in the SW. corner result in considerable local complexity. Strip mines on the W. flank of Turtle Mountain anticline produce bituminous coal from the Lower Cretaceous Kootenay formation. --P. Harker.

1-2405. Leech, G.B. CANAL FLATS, KOOTENAY DISTRICT, BRITISH COLUMBIA: Canada, Geol. Survey, Map 24-1958, scale 1:63,360, 2 secs., marginal notes, 1959.

Preliminary series geological map of some 381 sq. mi. on the W. flank of the Rocky Mountains. The area also straddles the Rocky Mountain trench and the eastern foothills of the Purcell Range. The part of the area covering the Purcell Range is underlain largely by late Precambrian rocks of the Purcell and Windermere series. These have been intruded by late Mesozoic granitic rocks. The Rocky Mountains are underlain by a series of limestones and clastic sediments ranging in age from Lower Cambrian to Mississippian. These form relatively narrow northwesterly trending belts interrupted by many faults, some following the main trend and some cutting abruptly across it. The Rocky Mountain trench in this region is the locus of a complicated and extensive fault system, in essence following the trend of the trench but in detail crossing it in many irregular directions. --H.M.A. Rice.

1-2406. Price, R.A. FLATHEAD, BRITISH COLUMBIA AND ALBERTA: Canada, Geol. Survey, Map 1-1959, scale 1:63,360, 3 secs., marginal notes, 1959.

Preliminary series geological map of some 200 sq. mi. in the southern Rocky Mountains, embracing parts of the foothills and the Flathead, Clark, and MacDonald ranges. Two main structural elements occur: an older group of low angle faults and thrust faults dominated by the Lewis thrust, and a younger group of normal faults with mainly vertical displacements. Precambrian, Cambrian, Devonian, Mississippian, Pennsylvanian, Permian, Triassic, Jurassic, and Cretaceous rocks are present. Cenozoic rocks occur, especially in the valley of Flathead River. The thick Precambrian sequence is mainly sedimentary and comprises formations recognized in the adjoining Carbondale and Waterton areas. --P. Harker.

1-2407. Neale, E.R.W. and David M. Baird. NIPPERS HARBOUR, NEWFOUNDLAND: Canada, Geol. Survey, Map 22-1958, scale 1:63,360, marginal notes, 1959, 4 refs.

Preliminary series geological map of some 200 sq. mi. on the NE. coast of Newfoundland. The area is underlain by a succession of clastic sediments and volcanic rocks of Ordovician and possible Devonian age. These have been divided into 4 groups whose age relations are imperfectly understood. They rest on gneissic rocks and quartzite of possibly Precambrian age, and all but the youngest group are intruded by small, tabular bodies of serpentinized basic rock distributed mainly in an arcuate belt, probably along a fault zone. All rocks mentioned so far are cut by intrusions ranging in composition from quartz-feldspar porphyry and granite to gabbro, but mainly acidic. They are probably of Devonian age and cover about half the area. The general strucutral trend is northwesterly with tight folding and complex faulting in places.

Asbestos occurs in the serpentine. Copper and lead sulfides have been observed, almost exclusively in sheared and chloritized volcanic rocks of Ordovician age. --H.M.A. Rice.

1-2408. Canada, Geological Survey. BATHURST ISLANDS GROUP, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Its: Map 18-1959, scale 1:506,880, 1959.

Preliminary series geological map covering part of Queen Elizabeth Islands, Canadian Arctic archipelago. Much of Bathurst Island is occupied by Parry Islands fold belt. Ordovician, Silurian, and Devonian strata are folded in alternating broad synclines and narrower anticlines trending E. or slightly N. of E. Permian, Triassic, and Jurassic rocks on Cameron Island, NE. of Bathurst, rest unconformably on older rocks and are not involved in the folding. Southern Bathurst Island, consisting mainly of Upper Devonian sandstones, in part nonmarine, lies S. of the main fold belt and is relatively undisturbed. Geology by personnel of Operation Franklin, 1955. --P. Harker.

1-2409. Canada, Geological Survey. DEVON ISLAND, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Its: Map 20-1959, scale 1:506,880, 1959.

Preliminary series geological map covering part of Queen Elizabeth Islands, Canadian Arctic archipelago. A thick, mainly marine sequence includes Ordovician, Silurian, Devonian, Permian, and Cretaceous rocks, with Archean or Proterozoic rocks at the base. Map has brief comments on regional relationship of Permian rocks, exposed only at the extreme northern tip of Devon Island (Grinnell Peninsula), and also on the correlation of Devonian and Silurian formations of southwestern Devon Island. --P. Harker.

1-2410. Canada, Geological Survey. NORTHERN PRINCE OF WALES, SOMERSET, AND NORTHWESTERNMOST BAFFIN ISLANDS, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Its: Map 19-1959, scale 1:506,880, 1959.

Preliminary series geological map of some 20,000 sq. mi. immediately S. of Lancaster Sound. The land area forms part of the Arctic lowlands, is of low relief, and consists mainly of Ordovician and Silurian rocks. Some Devonian rocks may occur. Gentle N.-trending structures on the W. side of Somerset Island expose Archean and Proterozoic rocks cut by numerous gabbroic sills and dikes. Geology by personnel of Operation Franklin, 1955. --P. Harker.

1-2411. Canada, Geological Survey. SOUTHERN ELLESMERE, GRAHAM, AND NORTH KENT ISLANDS, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Its: Map 21-1959, scale 1:506,880, 1959.

Preliminary series geological map covering part of Queen Elizabeth Islands, Canadian Arctic archipelago. Region lies at eastern end of Sverdrup basin and includes part of Eureka Sound and central Ellesmere fold belts. A thick, mainly marine sequence of rocks representing almost all geological systems rests on Archean or Proterozoic basement rocks. Igneous rocks are limited to scattered gabbro dikes on Bjorne Peninsula, Raanes Peninsula and S. of Starfish Bay. Geology by personnel of Operation Franklin, 1955. --P. Harker.

1-2412. Davison, W.L. LAKE HARBOUR, BAFFIN ISLAND, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 29-1958, scale 1:63,360, marginal notes, 1959.

Preliminary series geological map of some 210 sq. mi. around Lake Harbour, southern Baffin Island. Except for some Proterozoic diabase dikes, all rocks in the area are high grade metamorphic gneisses, schists, crystalline limestones, and granulites, of probable Archean age. The area has been complexly folded. In the E. and NE. it is characterized by broad dome and basin structures; in the SE., easterly trending formations have been bent into broad, asymmetrical folds with northerly trending axial plains; elsewhere folds trend northerly and are commonly tight isoclinal structures in which one limb is overturned. In many places gently plunging folds are seen to have been superimposed on earlier isoclinal folds. In detail, many beds are highly contorted, and limestone beds show pinch and swell structure and other evidence of flowage.

Mica was mined in the area at various times from the middle of the last century until the 1930's. Garnet is reported to have been shipped from the vicinity of Glasgow Inlet by the Hudson Bay Mining Company. Although graphite has apparently not been mined, a deposit at Bruce Harbour was worked by the Hudson's Bay Company during World War I. --H. M. A. Rice.

1-2413. Heywood, W.W. ELLEF RINGNES, AMUND RINGNES, CORNWALL, AND LOUGHEED ISLANDS, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 14-1959, scale 1:506,880, 1959.

Preliminary series geologic map covering part of the Queen Elizabeth Islands, Canadian Arctic archipelago. Structural trends are SW. to NE. Marine and nonmarine sediments are assigned to the Pennsylvanian and/or Permian, Triassic (?), Jurassic, Cretaceous, and Tertiary. They are overlain by undifferentiated Cenozoic deposits. Minor coal deposits occur in Jurassic and Cretaceous rocks. Igneous rocks comprise Pennsylvanian or Permian lava flows, and Cretaceous gabbro and diorite. --P. Harker.

1-2414. Taylor, F.C. NONACHO LAKE, DISTRICT OF MACKENZIE, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 10-1959, scale 1:253,440, marginal notes, 1959, ref.

Preliminary series geological map of some 2,000 sq. mi. of the Canadian Shield. All the rocks are of Precambrian age. The oldest are quartzite, graywacke, and paragneiss that occur as narrow bands in granitic rocks. A few areas of clastic sediments of the Nonacho group are present. In places these overlie the granitic rocks and in places they are intruded by them. As the 2 suites of granitic rocks are similar, they can only be distinguished where rocks of the Nonacho group are present and have not been separated on the map.

The regional structural trend throughout the map area is to the NE., although within this trend local variations are common. Most of the structural history is beyond the scope of the mapping, but within the Nonacho group some structure is recognizable. --H. M. A. Rice.

1-2415. Taylor, F.C. PENYLAN LAKE-FIREDRAKE LAKE, DISTRICT OF MACKENZIE, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 8-1959, scale 1:253,440, marginal notes, 1959, ref.

Preliminary series geological map showing the results of a reconnaissance of some 6,900 sq. mi. of the Canadian Shield E. of Great Slave Lake and about 140 mi. N. of Uranium City, Saskatchewan. Most of the area is underlain by granites and granulites, but lenses and some large irregular areas of paragneiss are plentiful. A few plutons of gabbro and diorite occur in the W. half of the area, and a small patch of arkose, quartzite, and conglomerate, belonging to the Nonacho group, occurs at the W. boundary of the area.

Only the main structural trends, E., NE., and N., are known. Within these trends local variations are common and undoubtedly complex. Foliation commonly changes from vertical to nearly flat in short distances, and in the E. part of the map-area is in places horizontal. --H. M. A. Rice.

1-2416. Taylor, F.C. WHOLDAIA LAKE WEST, DISTRICT OF MACKENZIE, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 9-1959, scale 1:253,440, marginal notes, 1959.

Preliminary series geological map of some 4,700 sq. mi. of the Canadian Shield adjoining the northern border of Saskatchewan. All the bedrock present is of Precambrian age, the oldest being quartzite, hornblende, gneiss, and paragneiss. Only in the SE. corner of the map-area are the quartzite and hornblende found in bodies large enough to be mapped separately. More than half the area is underlain by gneissic and massive granitic rocks. A few small areas of gabbro and amphibolite are present. These are of uncertain age and may be older than the granitic rocks.

The main structural trend is E. in the W. part of the area, to NNE. in the SE. part. Within this trend local folding is complex to a degree beyond the scope of reconnaissance mapping. Close folding is evident in some outcrops and is probably a common structural feature. --H. M. A. Rice.

1-2417. Chown, E.H. CARROLL LAKE (EAST HALF), KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Map 25-1958, scale 1:253,440, marginal notes, 1959.

Preliminary series geological map of some 3,000 sq. mi. in northwestern Ontario. Most of the area is underlain by coarse-grained, gray to pink granodiorite and quartz diorite, with minor amounts of diorite and granite, all of Precambrian age. Scattered through these massive rocks are lenses and irregular bodies of feldspar-quartz gneiss with either biotite or hornblende. These trend northerly or northwesterly. In the extreme SE. corner is an easterly trending belt of older sedimentary and volcanic rocks, which are probably the less metamorphosed equivalents of the gneisses. These are intruded by quartz porphyry bodies older than the granitic rocks. Glacial striae are present over the whole area, striking N.60°W. Some Au-bearing quartz veins are present in the SE. corner of the area and have been explored to a limited extent.--H.M.A. Rice.

1-2418. Kirwan, L.D. DEER LAKE (EAST HALF), ONTARIO: Canada, Geol. Survey, Map 26-1958, scale 1:253,440, marginal notes, 1959.

Preliminary series geological map of 2,900 sq. mi. in northwestern Ontario. The surface of the area is an uneven rocky plain that lies 950 to 1,150 ft. above sea level. Except for one narrow belt of greenstones on the western border of the area, the only rocks exposed are Precambrian granites, granodiorites, and related rocks. These are both massive and gneissic, the latter with a general northwesterly foliation that dips steeply westerly.--H.M.A. Rice.

1-2419. Craig, B.G. BATTLEFORD, WEST OF THIRD MERIDIAN, SASKATCHEWAN: Canada, Geol. Survey, Map 15-1959, scale 1:253,440, marginal notes, 1959.

Preliminary series map of an area in western Saskatchewan showing distribution of glacial and postglacial deposits. The area was covered by Laurentide glaciers; there is some slight evidence of more than one glaciation. Ice flow and ice-marginal features indicate that the last glacial movement occurred in 2 phases, mainly slightly W. of S., followed by restricted movement to the SE. Final retreat took place to the NW. and N. The many drumlins, all approximately oriented parallel with the North Saskatchewan River, especially around North Battleford, are a notable feature.--P. Harker.

1-2420. Cooper, J.R. RECONNAISSANCE GEOLOGIC MAP OF SOUTHEASTERN COCHISE COUNTY, ARIZONA: U.S. Geol. Survey, Mineral Inv. Map MF-213, scale 1:125,000, contour interval 100 ft., 1959.

1-2421. Petersen, Richard G. PRELIMINARY GEOLOGIC MAP OF THE EMMETT WASH NE QUADRANGLE, COCONINO COUNTY, ARIZONA: U.S. Geol. Survey, Mineral Inv. Map MF-215, scale 1:24,000, contour interval 40 ft., lat. 36°37'30"-36°45'N., long. 111°45'-111°52'30"W., 1959.

1-2422. Pomeroy, J.S. PHOTOGEOLOGIC MAP OF THE HURRICANE CLIFFS 2 NW QUADRANGLE, MOHAVE COUNTY, ARIZONA: U.S. Geol. Survey, Misc. Inv. Map I-293, scale 1:24,000, lat. 36°52'30"-37°N., long. 113°22'30"-113°30'W., 1959.

1-2423. Jennings, Charles W., comp. GEOLOGIC MAP OF CALIFORNIA: SAN LUIS OBISPO SHEET: California, Div. Mines, scale 1:250,000, contour intervals 100 and 200 ft., 2 sheets: geol. map, strat. nomenclature, 3 illus., 1959, 20 refs.

1-2424. Ekren, E.B., and F.N. Houser. PRELIMINARY GEOLOGIC MAP OF THE CORTEZ SW QUADRANGLE, MONTEZUMA COUNTY, COLORADO: U.S. Geol. Survey, Mineral Inv. Map MF-217, scale 1:24,000, lat. 37°15'-37°22'30"N., long. 108°37'30"-108°45'W., 1959.

1-2425. Houser, F.N., and E.B. Ekren. PRELIMINARY GEOLOGIC MAP OF THE MOQUI SW QUADRANGLE, MONTEZUMA COUNTY, COLORADO: U.S. Geol. Survey, Mineral Inv. Map MF-216, scale 1:24,000, lat. 37°15'-37°22'30"N., long. 108°52'30"-109°W., 1959.

1-2426. Rose, William D. COAL MINE MAP OF WESTERN KENTUCKY: Kentucky Geol. Survey, Ser. 10, scale 1:250,000, 1959.

Map shows location of coal mines producing more than 5,000 tons in 1958. Coal mines are symbolized as to type: drift, strip, auger, slope, and shaft. Ninety-nine mines are located; name of operating company and mine name are given. The base map was adapted from Kentucky transportation maps, U.S. Dept. of Commerce. Information was compiled in cooperation with the Kentucky Dept. of Mines and Minerals.--T.J. Crawford.

1-2427. Nosow, Edmund, and Roger B. Potts. PRELIMINARY OIL AND GAS MAP, BREATHITT COUNTY, KENTUCKY: Kentucky Geol. Survey, Ser. 10, scale 1:48,000, June 1959.

This map was prepared primarily to show the general trend of oil and gas exploration and development in the area, and for use as a tool in further exploration. Four hundred wells are located and identified by farm name; operator, elevation, and total depth of the wells are given where known. Oil and gas pools are named and producing horizons indicated. The base map of Breathitt County was adapted from recent U.S. Geological Survey 7.5 minute planimetric sheets, and provides an accurate base for continuing oil and gas investigation in the county and for posting new data as it becomes available.--T.J. Crawford.

1-2428. Stewart, John C. GEOLOGY OF THE DRYHEAD-GARVIN BASIN, BIGHORN AND CARBON COUNTIES, MONTANA: Montana Bur. Mines & Geology, Spec. Pub. 17 (Geol. Inv. Map no. 2), scale 1:63,360, columnar and cross secs. and text on map sheet, Jan. 1959.

The Dryhead-Garvin basin is a structural and topographic basin located in S.-central Montana between the Bighorn Mountains and the Pryor Mountains. Prominent N.- to NW.-trending faults separate the basin from these ranges. About 5,000 ft. of relief exists between the peaks and the basin floor. The Bighorn River is entrenched 1,000 ft. below the basin floor in its spectacular canyon.

The sedimentary rocks in the basin range from Middle Cambrian to Early Cretaceous age with perhaps only the Silurian period not represented. The previously defined formational units were found to be adequate, and only minor changes were made; demotion of the Mississippian Madison limestone to formational rank, determination of a Devonian section considerably thinner than previously reported, and correlation of the complex Permian sequence to the recently defined Goose Egg formation.

Structurally the basin and its borders are marked by very high-angle faults and monoclines, the notable exception being the thrust that fronts the high Pryor block. Vertical forces may have dominated in the structural evolution of the area. Physiographic evidence is presented that points to recent movement on the Garvin fault.

Pediments are extensive, and their development is attributed to parallel retreat of their headward slope due to back weathering and sheetwash. These pediments, probably Pleistocene in age, appear to be graded to a lithologic local base level and thus have no time significance. --Auth.

1-2429. Sandberg, D.T. STRUCTURE CONTOUR MAP ON TOP OF THE MIDDLE MEMBER OF THE PIPER FORMATION OF MIDDLE JURASSIC AGE IN THE WILLISTON BASIN AND ADJACENT AREAS IN MONTANA, NORTH DAKOTA, AND SOUTH DAKOTA: U.S. Geol. Survey, Oil & Gas Inv. Map OM-179, scale 1:760,320, 1959.

The structure of the top of the middle member of the Piper formation is shown over an area of about 100,000 sq. mi. Well information includes the location, status, and age of deepest rocks penetrated. Also shown are axes of folds, faults, and outlines of oil and gas fields. A cross section of electric logs shows the stratigraphic position of the contoured horizon across northern Montana and North Dakota. A lithologic and electric log illustrates part of a typical Jurassic section in northeastern Montana. --U.S. Geol. Survey.

1-2430. Twiss, Page C. GEOLOGY OF VAN HORN MOUNTAINS, TEXAS: Texas, Univ., Bur. Econ. Geology, Geol. Quad. Map no. 23, scale 1:48,000, 2 secs., text on map sheet, Aug. 1959.

In this area near Van Horn in Trans-Pecos Texas, bedrock includes Precambrian metamorphic rocks and pegmatites, Permian, Comanchean, and Gulfian sedimentary rocks, and Tertiary intrusive, volcanic, pyroclastic, and sedimentary rocks. Younger surficial deposits include bolson fill, terrace deposits, colluvium, and alluvium. Rock units are shown in color, and the text discusses stratigraphy, structure, and economic geology. --J. T. Lonsdale.

1-2431. Hemphill, W.R. PHOTOGEOLOGIC MAP OF THE NOTOM 1 QUADRANGLE, WAYNE COUNTY, UTAH: U.S. Geol. Survey, Misc. Inv. Map I-294, scale 1:24,000, lat. 38°22'30"-38°30'N., long. 111°-111°07'30"W., 1959.

1-2432. Marshall, C.H. PHOTOGEOLOGIC MAP OF THE DESERT LAKE 4 QUADRANGLE, EMERY AND CARBON COUNTIES, UTAH: U.S. Geol. Survey, Misc. Inv. Map I-295, scale 1:24,000, lat. 39°22'30"-39°30'N., long. 110°52'30"-111°W., 1959.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Geohydrology 1-2579, 1-2580, 1-2581, 1-2586 1-2587, 1-2588; Fuels 1-2614, 1-2630; Engineering Geology 1-2650.

1-2433. Edmonton Geological Society. 1959 FIELD TRIP GUIDE BOOK. CADOMIN AREA: 27 p., 6 illu 2 maps, strat. column, 5 measured secs., Edmont Alberta, [Aug.] 1959.

Edited by J. P. Leeson, this first guidebook of the Society contains a road log by G. W. Peterson, Jack Devine, and Gerry Genik which includes maps, figures, and measured sections from Edson to the McLeod River-Cardinal River divide. Three of the measured sections are original, including one by E. W. Best. --R. S. Taylor.

The guidebook contains 4 papers listed below, on various aspects of the Cadomin area. The paper by G. B. Mellon is abstracted separately.

Warren, P. S. Short History of the Cadomin Area p. 8.

Mellon, G. B. LOWER CRETACEOUS STRATA O THE CADOMIN AREA, p. 9-12.

Taylor, Richard Spence. The Cadomin Caves: A Note, p. 13-14.

Peterson, G. W. Economic Geology, p. 15-16.

1-2434. Mellon, G.B. LOWER CRETACEOUS STRATA OF THE CADOMIN AREA (In: Edmonton Geologi al Society. 1959 Field Trip Guidebook. Cadomin Area: p. 9-12, Edmonton, Alberta, [Aug.] 1959).

Lower Cretaceous strata of the Cadomin area include the lower part of the Blackstone formation, th rocks of the Blairmore group, and the upper part of the Nikanassin formation.

The lower part of the Blackstone formation consi of sparsely fossiliferous dark gray silty shales and thin-bedded quartzose siltstones of marine origin. The division between the Upper and Lower Cretace strata at Cadomin is marked by a thin sandy membe near the base of the formation which carries abundant fish scales, and is correlative with the fish scale sand of the plains area. The contact with the underlying Blairmore formation is sharp but confor able.

The rocks of the Blairmore group can be divided into 2 distinct mappable units using the mineral composition of the sandstones as a criterion. Sandstones of the lower Blairmore unit are predominant quartzose, cherty rocks interbedded with dark gray silty shales and thin coal seams carrying a nondico ledonous flora. The base of the unit is marked by a chert and quartzite pebble conglomerate, and the top by ostracode-bearing silty shales overlain by a dark gray marine shale member.

Sandstones of the upper Blairmore unit contain a high proportion of feldspathic and volcanic detritus, with an increasing amount of green authigenic chlor towards the top of the sequence. Commercial coal seams occur in the lower part of this feldspathic series throughout the central foothills, and the ass ciated nondicotyledonous flora is similar to that of the lower Blairmore unit. The upper part of the Blairmore group in the Crowsnest Pass region, cha acterized by its dicotyledonous flora and its lack of volcanic detritus, is absent in the Cadomin area through erosion or nondeposition.

The Nikanassin formation consists of quartzose, cherty sandstones and dark gray silty shales similar to the rocks of the lower Blairmore unit. They are separated from the latter by the widespread conglomerate at the base of the Blairmore group, but grade below into the dark gray marine shales of the Fernie formation. Plant fossils in the upper part of the formation suggest a correlation with the Lower Cretaceous Kootenay formation of southern Alberta. --Auth.

1-2435. Leech, G.B. FERNIE MAP-AREA, WEST HALF, BRITISH COLUMBIA (Report and Map 20-1958): Canada, Geol. Survey, Paper 58-10, 40 p., geol. map scale 1:126,720 (in pocket), 1958, 8 refs.

Preliminary account of the geology of some 2,500 sq. mi., partly in the Rocky Mountains and partly in the Purcell Mountains, the 2 being separated by the Rocky Mountain trench which runs northwesterly through the area. On the Purcell Mountains W. of the trench, and on the front ranges of the Rocky Mountains, bedrock consists mainly of Proterozoic rocks of the Purcell series. These are cut by a few bodies of granitic rocks and are variously folded and segmented by several large arcuate northeasterly trending thrust faults and by more northerly trending splays off them. The Rocky Mountains are underlain by a succession of sediments ranging in age from Lower Cambrian to Triassic. These are tightly folded in a northwesterly direction and sliced by faults, mostly with the same trend.

Sulfide deposits are common, mainly in the Proterozoic rocks. Two of these, the Kootenay King and the Estella, were recent producers of Pb and Zn. Gypsum deposits of significant size occur at several places, and gypsum has been produced for the cement industry. --H. M. A. Rice.

1-2436. Muller, J.E. KLUANE LAKE MAP-AREA, YUKON TERRITORY (Report and Map 19-1958): Canada, Geol. Survey, Paper 58-9, 9 p., geol. map scale 1:253,440 (in pocket), 1959.

Preliminary account of the geology of some 6,500 sq. mi., half of which embraces the NE. ranges of the St. Elias mountains. Crossing the area from NW. to SE. is the Shakwak valley which not only separates the St. Elias system from the Yukon plateau but is the boundary between 2 dissimilar geological regions.

NE. of the Shakwak valley is a complex of metamorphic and intrusive, partly migmatic rocks of Precambrian and/or early Paleozoic age, cut by Mesozoic granitic rocks and overlain here and there by probable Tertiary lavas. SW. of the valley is a structurally complex assemblage of Devonian to Tertiary sedimentary, volcanic, and intrusive rocks. A layer of white-ash and pumice overlies most of the area, probably from a center of eruption in the vicinity of Mt. Natazhat in Alaska.

The main structural feature of the map-area is the Shakwak lineament, a tectonic hinge line separating the geanticlinal basement complex of the Yukon plateau from the more recently folded Paleozoic-Mesozoic St. Elias geosyncline.

The area has been a minor placer Au producer since 1903. Native Cu occurs at several places but has not been found in economic amounts. Between 1952 and 1958 irregular lenses of pyrrhotite with minor pentlandite were found in Kluane range and developed, but work has been suspended. Coal, gypsum, and barite occur. --H. M. A. Rice.

1-2437. Geological Society of Sacramento. ANNUAL FIELD TRIP, GEOLOGICAL SOCIETY OF SACRAMENTO, APRIL 19-20, 1958. EAST SIDE SACRAMENTO VALLEY - MOTHER LODE AREA, CALIFORNIA: 18 p., 3 maps (2 fold.), fold secs., Sacramento, California, 1958.

Topics and features at 15 scheduled stops included: marine Cretaceous, the Mehrten formation, lithomarge, marine Eocene, anticline in Mariposa formation, Logtown ridge, Carson Hill mine, Columbia gold mining site, granodiorite quarry, Valley Springs rhyolite quarry, a fault zone, Cosumnes formation, Valley Springs filled channel in plutonic rock, Calaveras schist, and Jackson butte. Maps included are: route map, generalized geologic map showing route and stops, scale approx. 1 in. to 3 mi., and detailed geologic map and section in the vicinity of San Andreas, scale approx. 1 in. to 1 mi. --M. Russell.

1-2438. Higgins, James W., ed. A GUIDE TO THE GEOLOGY AND OIL FIELDS OF THE LOS ANGELES AND VENTURA REGIONS: 204 p., 88 figs. incl. illus. (1 col.), maps (2 fold.), charts (1 fold.), secs. (1 fold.), graphs, tables, Los Angeles, American Association of Petroleum Geologists, Pacific Section, 1958, refs.

The volume was prepared for the annual meeting of the American Association of Petroleum Geologists and the Society of Economic Paleontologists and Mineralogists, Los Angeles, March 10-13, 1958. It deals with the petroleum geology of the Los Angeles basin, one of the most prolific for its size in the world, and the Ventura basin, only slightly less prolific, as well as with the setting of these basins in the diverse, complex, and well-exposed geology of southern California. The volume contains illustrated logs of 5 field trips (one 350-mi. air tour of southern California, 3 one-day road logs in the Los Angeles basin, and a one-day trip in the Ventura basin). Supplementing these are 8 papers of regional or general interest, 19 oil-field papers, a complete, up-to-date oil field correlation chart for each of the 2 basins, and an air photo mosaic of the Los Angeles region. In addition to the numerous line drawings, maps, cross-sections, etc., there are 9 air views of outstanding geological features such as the San Andreas fault, including one in color of the Oak Ridge anticline with its outcropping red beds. All papers but one were written especially for this volume; some are a fresh presentation of previously published data while others report original thoughts and research results. These papers are of significance to any geologist working in southern California. They run the gamut from brief to exhaustive and from applied to theoretical in treatment. --H. H. Sullwold, Jr.

The following 34 papers are included in this guide book:

REGIONAL GEOLOGY OF SOUTHERN CALIFORNIA

Jahns, Richard H. The Geologic Framework of Southern California, p. 1-15, 27 refs.

Crowell, John C. The San Andreas Fault in Southern California, p. 17-19, 16 refs.

Shelton, John S. Air Tour of Southern California Geology (Field Trip A), p. 21-35, 5 refs.

THE LOS ANGELES REGION

Barbat, William F. The Los Angeles Basin Area, California, p. 37-49, 41 refs.

Conrey, B. L. Depositional and Sedimentary Patterns of Lower Pliocene-Repetto Rocks in the Los Angeles Basin, p. 51-54, 6 refs.

Eaton, Gordon P. Miocene Volcanic Activity in the Los Angeles Basin, p. 55-58, 13 refs.

Wissler, Stanley G. Correlation Chart of Producing Zones of Los Angeles Basin Oil Fields, p. 59-61, 7 refs.

Rothwell, W. T., Jr. Western Los Angeles Basin and Harbor Area (Field Trip B), p. 65-73, 15 refs.

Richardson, J. O., and D. N. Klemme. Alamitos Oil Field, p. 75.

Harris, Paul B. Long Beach Airport Pool, p. 75-77.

See, Paul D. Northern Los Angeles Basin (Field Trip C), p. 79-93, 10 refs.

Jamison, H. C., and R. J. Malloy, Bandini Oil Field, p. 97-99.

Jamison, H. C., and R. J. Malloy. Boyle Heights Oil Field, p. 99.

Elmore, W. Z. Santa Fe Springs Oil Field, p. 101-104, 3 refs.

Heath, E. G. Yorba Linda Oil Field, p. 105, ref.

Scribner, M. K. Brea Canyon Area, p. 107-108. 4 refs.

Woodward, A. F. Sansinena Oil Field, p. 109-118.

Gardett, Peter H. Geology and Related Problems in a Portion of the Los Angeles Basin, p. 119-121.

Jenkins, Olaf and Cordell Durrell. Geology of a Portion of the Eastern Santa Monica Mountains, Los Angeles County (Abstracted from California Division of Mines, Bulletin 170), p. 123-124, 5 refs.

Sullwold, Harold H., Jr. Turbidity Currents in the Modelo Formation of the Santa Monica Mountains, p. 125-127, 2 refs.

Schoellhamer, J. E., and John G. Vedder. Southeastern Los Angeles Basin (Field Trip D), p. 129-133.

Willis, Robin. Sunset Beach Oil Field, p. 135-141.

Allen, D. R., and J. E. Joujon-Roche. West Newport Oil Field, p. 143-144.

Goodban, F. R. San Clemente Oil Field, p. 145-148, ref.

Saunders, Norris E. Olive Oil Field, p. 149-151.

Michelin, James. Manhala Oil Field, p. 153.

THE VENTURA REGION

Field Trip Committee, R. M. Grivetti, Chairman. Ventura Basin (Field Trip E), p. 155-164.

Roth, George H., and Harold H. Sullwold, Jr. Cascade Oil Field, p. 167-171.

Dudley, Paul H. ; Jr. The Castaic Junction Oil Field, p. 173-176.

Henriksen, Donald A. Fillmore Oil Field, p. 177-179.

Ware, G. C., Jr., and R. D. Stewart. Bridge Area, South Mountain Oil Field, p. 181.

Jeffreys, S. R. Saticoy Oil Field, p. 183.

Hall, Edward A., Gerald H. Rickels, and W liam O. Plant. Oakridge Oil Field, p. 185-189.

Holman, William H. Correlation of Producin Zones of Ventura Basin Oil Fields, p. 191-199, 99 refs.

1-2439. Lydon, Philip A. GEOLOGY ALONG U.S. HIGHWAY 40, SACRAMENTO TO CALIFORNIA STATE LINE: California, Div. Mines, Mineral Inf. Service, v. 12, no. 8, p. 1-9, 2 illus., geol. map scale 1:125,000, Aug. 1959, 15 refs.

This paper is a brief, nontechnical guide to the geology visible along and near U. S. Highway 40 where it traverses the eastern half of the Great Val ley of California and crosses the Sierra Nevada. Four pages of the article are occupied by a geological strip map based on a field reconnaissance modi cation of U. S. Geological Survey folios and other published maps.

A simplified geological history of the Sierra Nevada is presented, beginning with the accumulation and moderate deformation of sediments and volcani rocks in a coastal geosyncline during the latter par of the Paleozoic era. The geosyncline continued to receive sediments and volcanic rocks until the begi ning of the Nevadan revolution in late Jurassic time when it was destroyed by strong folding, faulting, a batholithic intrusion. The new mountains thus form were eroded to low relief during Cretaceous and ea Tertiary time, and sediments accumulated in a relatively restricted trough to the W. A long period of intermittent volcanism and erosion, lasting from late Eocene to early Pliocene, covered parts of the Sierra with rhyolite tuff, andesitic pyroclastic debr and local basalt flows. Renewed Plio-Pleistocene u lift of the Sierra was followed by widespread glaciation and increased erosive activity.

A brief road log identifies the rock units shown the geologic map. --Auth.

1-2440. San Joaquin Geological Society, Bakersfiel California. SAN JOAQUIN GEOLOGICAL SOCIETY SPRING FIELD TRIP, ROUND MOUNTAIN AREA, MAY 17, 1958: [24] p., fold. map, fold. sec., [Bak ersfield], 1958.

The field trip covers the geology of the Round Mountain area of the E. side, San Joaquin Valley, and includes stratigraphic formations from the Jura sic "basement complex" to the Pliocene Kern River Stratigraphy, paleontology, and structure at the stops are discussed. Included are a road log, with geologic and geographic comments, and the followi short discussions: Stratigraphy, by Otto Hackel and K. F. Krammes: Macropaleontology, by C. C. Chur Structure - Round Mountain Area, by J. H. McMast Micropaleontology by R. Stanley Beck; and Oilfield Review by Tennant J. Brooks. --M. Russell.

1-2441. San Joaquin Geological Society, Bakersfie California. GUIDEBOOK, CHICO MARTINEZ CRE AREA, FIELD TRIP, MAY 9, 1959: 15 p., illus., maps, profile, 2 columns, [Bakersfield, Californi May 1959], 10 refs.

The guidebook includes a photo-mosaic of Temblor Range, California, from Carneros Creek to Salt Creek including Chico-Martinez and Zemorra creeks with geologic units plotted. A road log of t trip is given along with detailed notes on the micro paleontology and other geologic features at each stop. The guidebook also contains a topographic profile of the Chico-Martinez Creek area, scale 1 in. to 1,000 ft. --M. Russell.

1-2442. MacClintock, Paul, and H.B. Willman. GEOLOGY OF BUDA QUADRANGLE, ILLINOIS: Illinois State Geol. Survey, Circ. 275, 29 p., 4 maps (1 in pocket, scale 1:62,500), chart, 7 tables, 1959, 20 refs.

The Buda quadrangle in northwestern Illinois is along the N. border of the region underlain by strata of Pennsylvanian age, but in the quadrangle only strata from Herrin (No. 6) coal to Trivoli (No. 8) coal are exposed.

The quadrangle contains a complex sequence of glacial deposits of the Kansan, Illinoian, and Wisconsin stages. Kansan, and possibly also Nebraskan, deposits are not exposed but are a major part of the filling of the bedrock valleys, which include the deep valley of the ancient Mississippi River. A N.-facing escarpment on the S. side of that valley diverted early Wisconsin ice westward into the Green River lowland, forming the Green River lobe. The ice margin ascended the escarpment, which explains why the crests of the moraines are as much as 200 ft. higher on the upland than in the lowland.

In the relatively low area where the moraines cross the partially buried valley, features left by stagnant ice are prominent and contrast with the more typical morainal topography in adjacent areas. The Shelbyville and Bloomington morainic systems are part of the Tazewell drift. --Auth.

1-2443. Illinois State Geological Survey, Education Extension Section. GUIDE TO ROCKS AND MINERALS OF ILLINOIS: Illinois State Geol. Survey, Educ. Ser. 5, 40 p., illus., map, column, 1959.

This booklet furnishes a brief geological background and explanation of 35 common rocks, minerals, and fossils of Illinois. It also contains keys for the identification of rocks and minerals, a geologic map of Illinois, a geologic column showing succession of rocks in Illinois, and a suggested list of equipment which will be useful to the amateur rock and mineral collector. --Illinois State Geol. Survey.

1-2444. Grout, Frank F., Robert P. Sharp, and George M. Schwartz. THE GEOLOGY OF COOK COUNTY, MINNESOTA: Minnesota Geol. Survey, Bull. 39, 163 p. 28 figs., 54 maps (16 in pocket), Sept. 1959, 83 refs.

Cook County covers a triangular-shaped area of 1,680 sq. mi. at the extreme northeastern tip of Minnesota between Lake Superior on the S. and the province of Ontario on the N.

The geology is controlled in a broad way by its position on the N. limb of the Lake Superior syncline. With the exception of glacial deposits the rocks are all of Precambrian age. The older rocks consist of the Ely greenstone, Saganaga granite, and Knife Lake group. The Animikie rocks form a narrow E.-W. belt across the county and have been intruded by many sills and dikes of Keweenawan basic igneous rocks.

Over two-thirds of the county is underlain by rocks of Keweenawan age, consisting of a thin sandstone and conglomerate at the base, overlain by an exceedingly thick series of lava flows. These in turn, are intruded by the eastern part of the huge Duluth gabbro complex and by an extensive series of diabase sills, dikes, and irregular intrusions. A total of 92 flows were mapped between Grand Portage and Tofte.

The glacial drifts represent deposits from the Rainy Lobe which probably covered the entire county and are overlain near Lake Superior by deposits of the Superior Lobe.

Abandoned beaches of several glacial stages of Superior are well developed at places. A characteristic feature of the county are several hundred lakes, many elongated in an E.-W. direction in conformity with the strike of the formations. --G.M. Schwartz.

1-2445. Widmer, Kemble. FIELD TRIP TO LIMECREST, NEW JERSEY, OCTOBER 18, 1959: Keystone Newsletter, v. 8, no. 10, p. 3-4, map, diag., Oct. 1959.

Field trip was made by the Mineralogical Society of Pennsylvania to the Limestone Products Corporation Quarry at Limecrest, New Jersey. The quarry is in Precambrian limestone which strikes about N. 87°W. and dips about 23°NE. The mass is bordered on the E. by gneiss and is itself shot through with pegmatite veins associated with nearby granite masses and basic intrusions of a dioritic phase of dark gneiss. Twenty-six minerals have been reported from the quarry. --M. Russell.

1-2446. Panhandle Geological Society, Amarillo, Texas. GUIDEBOOK OF THE SOUTHERN SANGRE DE CRISTO MOUNTAINS. FIELD CONFERENCE, MAY 21, 22, 23, 1959: [166] p., illus., maps (2 in pocket), secs. (6 in pocket), diag., tables, [Amarillo, 1959], refs.

The field conference and guidebook were designed to acquaint the participants with the general geology of this part of northeastern New Mexico. Particular emphasis is placed on stratigraphy and basin geology to demonstrate petroleum possibilities of the region. Following an introduction by A.L. Thalman are resumes of geology and road logs for the three days of the field trip (p. 1-102). Seven papers are presented:

Krisle, Jack E. General Geology of the Tucumcari Basin of Northeastern New Mexico, 11 p., 7 refs. and list of sources of well information in northeast New Mexico.

Foster, Roy W. Petroleum Exploration in Northeastern New Mexico, 24 p., 15 refs.

Wendorf, Fred. Prehistory of Northeastern New Mexico, 13 p., 27 refs.

Bogart, Lowell E., and H.G. Brown, III. Photogeologic Clues to Structure in the Ocate Area, Mora County, New Mexico, 6 p.

Stanley, Rev. Father. Fort Union, 3 p.

O'Neal, Vivian. The Story of the Pecos Pueblo, 2 p.

Smith, Guy W., comp. Selected Bibliography of Northeastern New Mexico Geology, 5 p., 65 refs.

The following separate maps and cross sections are enclosed with the guidebook:

Baltz, Elmer H., and Charles B. Read. Generalized Geologic Cross Section of South Central and Northern Parts of Sangre de Cristo Mountains.

Krisle, Jack E. Tucumcari Basin and Adjacent Areas of Northeastern New Mexico; Isopachous Contours of Permo-Penn (Marine) Section.

Krisle, Jack E. North-South Cross Section, Tucumari Basin Area of New Mexico.

Krisle, Jack E. West-East Cross Section, Tucumari Basin Area of New Mexico.

Krisle, Jack E. Northeastern New Mexico, Contours on Top Precambrian Surface.

Smith, Guy W. Stratigraphic Section, Raton Basin-Sierra Grande Uplift.

Smith, Guy W. Stratigraphic Section, Las Vegas-Dalhart Basins.

Baltz, Elmer H., Charles B. Read, and A. A. Wanek. Diagrammatic Cross Sections of the Sangre de Cristo Mountains and Parts of the Raton Basin, New

1-2447. Society of Economic Paleontologists and Mineralogists, Permian Basin Section, and Roswell Geological Society, Roswell, New Mexico. GUIDEBOOK FOR JOINT FIELD CONFERENCE IN THE SACRAMENTO MOUNTAINS OF OTERO COUNTY, NEW MEXICO: 306 p., illus., maps, secs., Alamogordo, New Mexico, Apr. 1959, refs.

The road logs in this guidebook were written to be useful to subsequent visitors to the area as well as for the use of the field conference which was held Apr. 17 and 18, 1959. To that end a summary of remarks at each stop are included, also a composite stratigraphic section. The following road logs and papers are included in the guidebook:

Pray, Lloyd C. Road Log "A" Alamogordo to Alamo Canyon, p. 2-12.

Pray, Lloyd C. Road Log "B" Alamogordo South to Otero Mesa, p. 13-32.

Pray, Lloyd C. Road Log "C" Alamogordo to High Rolls, p. 33-37.

Wray, John L. Origin of Some Pennsylvanian Algal Bioherms in Southwestern United States, p. 38-43.

Pray, Lloyd C. Road Log "D" High Rolls South to Four Bits Peak, p. 44-57.

Oppel, T. W., Carel Otte, Jr., and Lloyd C. Pray. Road Log "E" High Rolls, New Mexico, through Fresnal Canyon to Tularosa, New Mexico, p. 58-71.

Pray, Lloyd C. Road Log "F" West Side Road and Crest Road Loop, p. 72-76.

Pray, Lloyd C. Road Log "G" High Rolls to Cloudcroft, p. 77-80.

Bachman, George O., V. P. Sheldon, and Rex Alcorn. Road Log - Cloudcroft to Artesia, New Mexico, p. 81-85.

Pray, Lloyd C. Stratigraphic and Structural Features of the Sacramento Mountain Escarpment, New Mexico, p. 86-130, 40 refs.

Cave, H. S. Notes on the History of Early Geologic Work as Related to the Sacramento Mountains, Otero County, New Mexico, p. 131-136, 6 refs.

Foster, Roy W. Precambrian Rocks of the Sacramento Mountains and Vicinity, p. 137-153, 17 refs.

Flower, Rousseau H. Cambrian-Devonian Beds of Southern New Mexico, p. 154-171, 19 refs.

Cline, L. M. Preliminary Studies of the Cyclical Sedimentation and Paleontology of the Upper Virgil Strata of the La Luz Area, Sacramento Mountains, New Mexico, p. 172-185, 8 refs.

Oppel, T. W. The Pennsylvanian-Permian Contact in Lower Fresnal Canyon, Sacramento Mountains, New Mexico, p. 186-195, 16 refs.

Otte, Carel, Jr. The Laborcita Formation of Late Virgilian-Early Wolfcampian Age of the Northern Sacramento Mountains, Otero County, New Mexico, p. 196-208, 9 refs.

Bachman, George O., and Philip T. Hayes. Resume of Upper Pennsylvanian and Lower Permian Stratigraphic Relations in the Sand Canyon Area, Otero County, New Mexico, p. 209-219, 7 refs.

Clark, Tracy. Sacramento Mountains, p. 220-222, 7 refs.

Motts, Ward S. Geomorphology of the East Side of the Sacramento Mountains, New Mexico, p. 223-233, 12 refs.

Mourant, Walter A. Ground Water in the Hondo Valley, Lincoln County, New Mexico, p. 234-235.

Hood, James W. Ground Water in the Tularosa Basin, New Mexico, p. 236-250, 28 refs.

Dunn, David A. Resume of Oil and Gas Exploration of the Sacramento Mountain Area, p. 251-254.

Christy, S. B., Jr. Land Classification in the Eastern Tularosa Basin and Environs, p. 255-258.

Kottlowski, Frank E. Sedimentary Rocks of the San Andres Mountains, p. 259-277, 27 refs.

Reynolds, C. B., and J. Campbell Craddock. Geology of the Jarilla Mountains, Otero County, New Mexico, p. 278-284, 3 refs.

Jicha, Henry L., Jr. The White Sands - A Short Review, p. 285-291, 7 refs.

Allen, John E. The Carrizozo Malpais, p. 292-294.

Packard, Frank A. Road Log from Stop IIIB Through Dunken to State Highway 83, p. 295-298.

Motts, Ward S., and Walter A. Mourant. Pajarito Peak Road Log, p. 300-303.

1-2448. Wilkinson, W.D. FIELD GUIDEBOOK - GEOLOGIC TRIPS ALONG OREGON HIGHWAYS: Oregon, Dept. Geology & Mineral Industries, Bull. no. 50, 148 p., 6 illus., 39 maps, June 1959, approx. 309 refs.

This guidebook has been prepared with a dual purpose in mind. First, to serve as a guide and reference book for college teachers of geology participating in the National Science Foundation sponsored conference. Second, to serve as a guide to the professional geologist and the layman who has an interest in geology and is desirous of visiting parts of Oregon that have particular geologic significance.

The guidebook contains the road logs of 7 trips, representing a total of 1, 100 mi. of geology along Oregon highways. The 7 trips are: 1) Corvallis to Newport via Depoe Bay; 2) Eugene to Coos Bay via Reedsport; 3) Corvallis to Prineville via Bend and Newberry Crater; 4) Prineville to John Day via Mitchell; 5) John Day to upper Bear Valley; 6) Logdell to Pine Creek (Jurassic); 7) Picture Gorge to Portland via Arlington.

Each of the trips listed emphasizes certain geologic features of Oregon. The first 2 coast trips are concerned with the Cenozoic geology of western Oregon. The Corvallis-Newberry crater trip develops the volcanic story, particularly the late Tertiary and recent vulcanism. Trips 4, 5, and 6 not only develop the Cenozoic story but detail the Mesozoic history as it is displayed in central Oregon. Trip 7 deals with the Columbia River gorge and the events related to its geologic history. These trips taken in their entirety display a cross-section of Oregon from late Paleozoic to recent times.

Geologic strip maps, as well as cross sections and other illustrations, accompany the trip logs to help clarify the geology. The position of each map in relation to the trip route is indicated on index maps and also in the logs. Absence of geologic maps for any trip or part of a trip generally indicates the absence of geologic mapping in that area.

The correlation charts in the guidebook include many formations occurring in Oregon. All formations are briefly identified in the alphabetical list with the charts. Those formations encountered on the trips, however, are described in more detail.

These descriptions appear under the heading "stratigraphic sequence," with the formations arranged from youngest to oldest and grouped according to the region in which they occur. They will be found accompanying the appropriate trips. --Auth.

1-2449. Siple, George E. GUIDEBOOK FOR THE SOUTH CAROLINA COASTAL PLAIN FIELD TRIP OF THE CAROLINA GEOLOGICAL SOCIETY, NOV. 16-17, 1957: South Carolina, State Devel. Board, Div. Geology, Bull. no. 24, 27 p., 3 maps, table, 1959, 52 refs.

Sedimentary formations of the Coastal Plain range from Late Cretaceous to Recent in age and consist of unconsolidated sand, clay, gravel, marl, and limestone which have been deposited on a surface of granite, schist, and gneiss thought to be an extension of rocks of the adjoining Piedmont province. Age designations of parts of the column are as yet uncertain, especially the basal unit of the Cretaceous system and the lower Tertiary series. On the basis of structure, lithology, and possibly paleontology, there is considerable evidence to indicate the presence of buried pre-Taylor to pre-Austin beds on the southern flank of the Carolina arch. The Paleocene series is recognized in the subsurface but only tentatively in surface exposures.

The sedimentary section thickens from a feather edge at the Fall Line to more than 3, 500 ft. along the coast S. of Charleston. Structural features of the basement rocks include the Cape Fear arch, a suggested basinal structure in the vicinity of the Savannah River valley, a basin in the Beaufort area, and a possible basement ridge aligned parallel to the coast in the vicinity of Savannah, Georgia. Three-point calculations indicate the average dip of the surface of the basement rocks is about 36 ft. per mi. to the SE. Dips of the sedimentary strata range from 33 ft. per mi. to less than 10 ft. per mi. Faulting in the unconsolidated sediments, though not identified specifically, is fairly certain to have taken place in some areas. --H. S. Johnson, Jr.

1-2450. Smith, L.N., and Henry S. Johnson, Jr. CAROLINA GEOLOGICAL SOCIETY, GUIDEBOOK [FIELD TRIP], NOVEMBER 1-2, 1958: [13] p., 2 maps, chart, [Columbia], South Carolina State Development Board, Division of Geology, 1958, 9 refs.

The guidebook consists of a road log covering an area W. and S. of Columbia. Ten stops were made during the 2-day trip, starting at the spillway on the S. end of Lake Murray dam and continuing S. and E., ending at Santee on the W. shore of Lake Marion. Stratigraphy, structure, and paleontology are briefly discussed at each stop. --A.C. Sangree.

1-2451. Hamilton, W.C., Jr., ed. A GUIDE TO THE STRAWN & CANYON SERIES OF THE PENNSYLVANIAN SYSTEM IN PALO PINTO COUNTY, TEXAS. Prepared for the regional meeting, American Association of Petroleum Geologists, Southwestern Federation of Geological Societies, Mineral Wells, Texas, October 22-25, 1958: 58 p., 17 illus., 5 pls., 8 maps (1 fold. scale 1:96, 000), 2 geol. columns (1 fold.), 2 tables, Wichita Falls, Texas, North Texas Geological Society, Oct. 1958, refs.

The guidebook attempts to relate the viewable surface crops with their appropriate, unseen counterparts in the Strawn and Canyon series of the Pennsylvanian system. A road log shows 15 stops. The following papers are included in the guidebook:

Brown, L. F., Jr. Review of Pennsylvanian Clay Mineral Industries, North Central Texas, p. 20-29, 5 refs.

Kollaja, Alvin A. Application of Fuller's Carbon-Ratio Theory in North Texas, p. 30-35, 7 refs.

Heuer, Edward. Comments on the Nomenclature Revision of the Strawn and Canyon Megafossil Plates, p. 36-47, 8 refs.

Kay, John A. The Canyon in the Wiles, p. 49.

Creager, Nance G., Barbara M. Creager, and Forrest H. Muire. Bibliography on the Pennsylvanian-Canyon and Strawn of North Texas, p. 50-56, approx. 230 refs. --M. Russell.

1-2452. West Texas Geological Society, Midland Texas. GUIDE BOOK, 1958 FIELD TRIP. FRANKLIN AND HUECO MOUNTAINS, TEXAS, NOVEMBER 6-7-8, 1958: 91 p., illus., maps (1 in pocket, scale 1 in. to 2 mi), secs., [1958], refs.

The purpose of the fall 1958 field trip was to view the structure, stratigraphy, and geomorphology of the Franklin and Hueco mountain groups of extreme W. Texas. Road logs of the trip include detailed discussions of the geologic features to be seen at each of the stops. The following technical papers are included; some are reprints or condensations of previously published works:

Paleontology and Geology of the El Paso Area (From the Emory Survey - published 1857), p. 28-29.

Pray, Lloyd C. Stratigraphic Section, Montoya Group and Fusselman Formation, Franklin Mountains, Texas, p. 30-43, 7 refs.

Hardie, Charles H. The Pennsylvania [sic.] Rocks of the Northern Hueco Mountains, p. 44-45, 5 refs.

Kottlowski, Frank E. Geologic History of the Rio Grande Nea El Paso, p. 46-54, 23 refs.

Knowles, Boyle B., and Richard A. Kennedy. Ground-Water Resources of the Hueco Bolson, Northeast of El Paso, Texas. Compiled for guidebook by George B. McBride, p. 55-66, 25 refs.

Strain, W. S. Juarez Mountains (Sierra del Paso del Norte), p. 67.

Small, Theodore A. El Cerro de Muleros (Cerro Cristo del Rey), p. 68-69, 2 refs.

Cooley, Beaumont. Oil Exploration in the Area of the Franklin and Hueco Mountains, p. 70-72.

Evans, Glen L. Notes on Mineral Resources of the El Paso Area, p. 73-74.

Woodside, T. J., and B. Roberts. The El Paso Smelter, p. 75-77.

McBride, George B. El Paso, a Historical Sketch, p. 78-84, 8 refs.

Ammon, Walter. Prominent Plants in and Near the Franklin and Hueco Mountains of West Texas, p. 85-91.

1-2453. West Texas Geological Society, Midland Texas. Highway Logging Committee. GEOLOGICAL ROAD LOG ALONG U.S. HIGHWAYS 90 and 80 BETWEEN DEL RIO AND EL PASO, TEXAS: 48 p., 17 maps (geol. map in pocket, scale 1:125, 000), 2 charts (1 in pocket), 1958.

The geology along portions of U. S. Highways 90 and 80 is given by means of maps, correlation charts, and brief text which would be most convenient to motorists. The following descriptions are included:

King, Philip B. Geology of the Marathon Region, p. 5-6.

Big Bend National Park, p. 6.

El Paso, Texas, p. 6.

Ammon, Walter. Wild Life Along Highways Between Del Rio and El Paso, Texas, p. 7-9.

Ammon, Walter. Prominent Plants Along Highway 80, p. 10-12.

Geologic timetable and stratigraphy charts are provided for the Del Rio, Marathon, Davis Mountains, Van Horn, Sierra Blanca, and El Paso areas (p. 13-19). Fourteen geologic road-log maps at about 1 1/2 in. to 1 mi. cover the route from Del Rio to El Paso (p. 20-47). --M. Russell.

1-2454. Harris, Rae L., Jr. GEOLOGIC EVOLUTION OF THE BEARTOOTH MOUNTAINS, MONTANA AND WYOMING. PART 3. GARDNER LAKE AREA, WYOMING: Geol. Soc. America, Bull., v. 70, no. 9, p. 1185-1216, 66 illus., 4 maps (1 fold. geol. map scale approx. 1 in. to 1,000 ft.), 2 diags., 2 graphs, 9 tables, Sept. 1959, 51 refs.

The Gardner Lake area is one of the key areas being studied in detail in the Beartooth Mountains, Montana and Wyoming. Foliation, compositional banding, and rock units indicate open southward-plunging folds traceable through metasediments and migmatites into granitic gneisses. The attitude of axial-plane foliation in highly contorted metasediments is found also in foliation trends of the gneisses. Complete gradations from metasediments to pink leucocratic gneiss are indicated by distribution of mappable units, abundance and composition of feldspars and ferromagnesian minerals, percentage and character of rounded and overgrown zircons, length-width ratios of zircons, and variations in chemical analyses. Replacement in situ by hot alkaline solutions seems the most likely origin for the granitic gneisses. Boudinage and rotation of amphibolite blocks within highly contorted feldspathized strata denote regional metamorphism prior to granitization. Mafic intrusive bodies are pregranitization, penegranitization, and postgranitization in age, and their major trends, NW. and NE., suggest that the present topographic expression is controlled by structural elements developed during feldspathization. Seven K-A and Rb-Sr ages on widely dispersed micas and feldspars indicate this event as 2.7 billion years ago. --Auth.

1-2455. Kaye, Clifford A. COASTAL GEOLOGY OF PUERTO RICO. GEOLOGY OF ISLA MONA AND NOTES ON AGE OF MONA PASSAGE: U. S. Geol. Survey, Prof. Paper 317-C, p. 141-178, 10 figs. incl. geol. map (in pocket) scale 2 in. to 1 mi., 5 tables, Aug. 1959, 82 refs.

Isla Mona and the nearby rock of Monito are situated in Mona Passage, about midway between Puerto Rico and the Dominican Republic. Isla Mona has an area of about 21 sq. mi. and Monito less than 1/4 sq. mi. Isla Mona is a limestone tableland, bounded by steep to vertical cliffs and fringed about its southern perimeter by a narrow low-lying coastal terrace. The climate of the island is semiarid; its mean annual rainfall is 38.1 in. The flora is xerophytic and consists mostly of cactus, leguminous plants, shrubs, and dwarfed trees. The density of the brush is surprising considering the sparse nature of the soil, and most of the larger plants seem to be rooted in narrow, soil-filled crevices in the limestone. The island was discovered by Columbus in 1494 during his second voyage. In early colonial times the island was a watering and provisioning station. At the present time its only inhabitants are the lighthouse crew. In the late 19th century the caverns with which the island abounds were extensively worked for their deposits of leached guano.

Except for the thin soil of the tableland, Isla Mona consists entirely of limestone and dolomite. The Isla Mona limestone forms most of the mass of both islands and is probably early or middle Miocene in age. One sample of rock when tested in the laboratory proved to be dolomite. Unfortunately, it is not known how much of the rock exposed in the vertical sea cliffs of the N. coast is dolomite nor whether the dolomite is confined to specific beds or represents irregular-shaped alterations of the limestone. The Isla Mona limestone is essentially flat lying, although apparent dips up to 3 1/2° are visible in the cliffs. No faults were noted. In places a relatively thin cavernous limestone, the Lirio limestone, overlies the Isla Mona limestone. At Punta Este the 2 formations are separated by a slight angular unconformity. Only one fossil, a coral, was found in the Lirio limestone, and from it the formation appears to be either Pliocene or Pleistocene in age. The low coastal terrace surrounding the S. side of the island is mostly an elevated reef of Pleistocene age, thinly veneered with sand. Lineations on the plateau surface (best seen from the air) presumably reflect jointing. These have roughly a radial pattern, which suggests that the island has undergone a slight doming deformation since Lirio time.

The scant reddish-brown residual soil of the tableland is a nonplastic, granular aggregate whose inorganic component consists mostly of a mixture of hematite, carbonaceous and amorphous substances (iron oxide?), boehmite, kaolinite, and mica. The soil is rich in P and N. Veins and vermicular structures of reddish impure limestone are common throughout the white limestones and probably represent soil washed into solution openings and later cemented by calcium carbonate. The cemented red residuum, as it is called, contains tests of land snails that point to a probable Pleistocene age for the deposit. The plateau surface is everywhere etched into a microrelief of about 1 ft. of sharp serations, pits, and enlarged joints. The plateau surface is very gently domed and is broken by several outward-facing low scarps, a few areas of large sinkholes, and low marginal limestone rims and ramparts. Both the residual soil (cemented and uncemented) and the rims and ramparts indicate that a considerable thickness (roughly estimated to have been about 85 ft.) of limestone has been dissolved from the surface of the plateau without having formed a pronounced relief. This points to the importance of surface reduction without dissection in at least the earlier stages of the geomorphic cycle in horizontally bedded pure limestones. The plateau is bounded by steep cliffs on the S. and by vertical sea cliffs on the N. coast. These sea cliffs plunge to depths estimated to be 16 to 22 fathoms. In the face of evidence of active cliff recession, the plunging nature of these cliffs provides an interesting geomorphic problem. The hypothesis that seems most consistent is that the Isla

Mona limestone is actually very friable, although it has a deceptive, casehardened shell where exposed subaerially. Turbulent surf working on the friable rock below sea level is deeply undermining the sea cliffs to a considerable depth, in consequence of which, cliff failure has not produced a platform at or close to present sea level. Hydrographic charts suggest that submarine levels and terraces mark the bank surrounding Isla Mona. There is probably a level of 22 fathoms close to the island on the E. side, and a terrace at 7 fathoms is indicated just outside the small barrier reef off the S. coast. Behind the reef the lagoon is about 2 fathoms deep. The narrow barrier reef, which for the most part lies only a few hundred yards offshore, merges with a fringing reef along part of the shore.

Both the Isla Mona and the Lirio limestones are cavernous, although the latter formation seems to be more so. Most caverns in the Isla Mona limestone on the S. coast are single storied, seem to be level, and have floors that seem to lie about 20 to 25 ft. above sea level. Caverns opening out onto cliffs on the windward (E.) side of the island generally have very much enlarged mouths, possibly due to solution by direct rainfall. Leached guano (a brown to white powdery material) occurs beneath the dripstone crust on the floors of all caverns. These deposits are no longer being mined although they are far from exhausted. The principal phosphate mineral is hydroxylapatite, with less crandallite, brushite, martinite, and monetite. In addition to the cave phosphorites, phosphatic limestone occurs at Punta Este at the unconformity between the Isla Mona and Lirio limestones. The replacement of limestone by hydroxylapatite is well illustrated by a petrographic study of this rock. The cave phosphorites are very probably bat guanos. They cannot be ascribed to birds, mainly because they occur deep within the caves in places where birds would not be able to fly because of the total darkness. A small part of the phosphate was probably derived from surface guano deposits leached and carried down to cavern level by infiltrating water. In addition to phosphatic minerals, deposits of finely pulverulent calcite were noted at several places about the island and may have formed by the disintegration of limestone, perhaps through the activity of an organic agent (algae?).

Mona Passage was probably already in existence in the Miocene and Pliocene (or early Pleistocene), when the Isla Mona and Lirio limestones were deposited. This is evident from the great purity (in terms of insoluble content) of these rocks as compared with limestones of Puerto Rico of early Miocene age. The great purity of the rocks of Isla Mona points to an oceanic-reef environment far from a source of land-derived sediment. The site of Isla Mona today fulfills this requirement because of the essentially oceanic nature of the currents that flow to the N. across the center of the strait. If this strait had not existed in the Miocene (that is, if Puerto Rico and Hispaniola had been a continuous landmass), the site of Isla Mona would have been traversed by W.-flowing coastal currents similar to those off the S. coast of Puerto Rico today, and presumably also off the S. coast of Puerto Rico in the early Miocene. The Isla Mona limestone was probably deposited in relatively shallow waters not too remote from reefs. The nature of the unconformity between the Isla Mona and Lirio limestones suggests marine planation within the wave zone. The thin layer of phosphatic limestone at the unconformity at Punta Este also points to the possibility of a preceding interval of subaerial reduction and guano accumulation. At the close of deposition of the Lirio limestone, the island possibly corresponded in dimension to the submarine bank that now surrounds Isla Mona. This means that since that time the shores of Isla Mona have receded as much as a mile while Isla Monito has been reduced by as much as 2 mi. A sequence of Quaternary climatic changes is indicated by various data.

The cemented red residuum possibly represents a transition from humid to less humid climate. The formation of the many large caverns by solution probably followed the cementation of the red residuum and possibly occurred during a period of very humid climate and high water table; the position of the water table may have been controlled by a higher sea level. The caverns were then drained, possibly as a result of a fall in sea level, and then were occupied by large colonies of bats. The climate may have been more humid than that of today. The interval of guano deposition was abruptly terminated and was followed by the deposition of dripstone in the caverns. This was possibly a response to a climate shift towards greater aridity, and it is speculated that this may have followed the postglacial warm interval. Historical records indicate that the climate of Isla Mona may have been more humid 300 to 450 years ago than it is today. --Auth.

2. GEOMORPHOLOGY

See also: Geologic maps 1-2419; Areal and Regional Geology 1-2433, 1-2442, 1-2455; Geophysics 1-2533; Fuels 1-2612.

1-2456. Melton, Frank A. AERIAL PHOTOGRAPHS AND STRUCTURAL GEOMORPHOLOGY: Jour. Geology, v. 67, no. 4, p. 351-370, illus., 11 maps (1 fold.), fold. profile, 7 charts, table, July 1959, 33 refs.

The intensive use of vertical aerial photographs to aid geological exploration during the last 2 decades has revealed serious weakness in some of the traditional concepts of American geomorphology. A new realization is now widely held, not by geomorphologists but by "photogeologists," namely, that tectonic elements of the crust (such as dipping strata, faults, joints, fold axes, flexures) can be found with aerial photographs in almost every square mile of the continental surfaces through their geomorphic expression. This has long been known of the deformed "mountain regions"; it is nearly as true of the so-called "plains" and "plateaus," even where tectonic elements are deeply buried by relatively undeformed, homoclinal strata.

The writer attempts to present a usable revision of geomorphic concepts mainly through 2 basic principles: 1) the concept of essentially universal superposition of drainage in "flatland" regions, as well as in most tectonic systems, and 2) the concept of an almost universal tectonic influence on most continental drainage. Exceptions to the control of principles 1 and 2 are some, but not all, of the streams on deltas, volcanoes, lava flows, dune plains, and elsewhere.

Elevated dissected bedrock benches of erosional origin are employed in explaining the usual process of stream adjustment to tectonic anomalies. The Pawhuska peneplain of central and southwestern central United States is briefly described. A distinction is made between tectonically influenced and tectonically adjusted drainage. --Auth.

1-2457. IGY World Data Center A: Glaciology. PRELIMINARY REPORTS OF THE ANTARCTIC AND NORTHERN HEMISPHERE GLACIOLOGY PROGRAMS: Its: IGY Glaciolog. Rept. Ser., no. 1, variously paged, illus., maps (part fold.), secs. (part fold.), profiles, graphs (part fold.), tables, New York, American Geographical Society, July 1958, refs.

This first volume of preliminary reports of the United States-IGY glaciology program is being issued by World Data Center A as part of the series of reports of the several disciplines. The reports in this first volume are very preliminary in nature and represent only partial coverage of the United States glaciology program. The principal purpose is to record the nature of the observations that have been made, the areas in which activities have been undertaken, and whatever tentative conclusions may be advanced. --From pref.

ANTARCTIC PROGRAM

Thiel, Edward and others. IGY Antarctic Oversnow Traverse Program, 1957-1958, 21 p.

Cook, John C. Preliminary Airlifted Geophysical Explorations in Antarctica, 12 p.

Vickers, Willian W. On Snow Accumulation and Meterologic Observations: Ross Ice Shelf and the Victoria Plateau; Preliminary Report Pending Results of Geochemical Analysis, 12 p.

Zumberge, James H. Preliminary Report on the Ross Ice Shelf Deformation Project, 24 p.

Core Drilling in Ice, Byrd Station, Antarctica, 12 p.

Pt. 1. Drilling Techniques, by Robert W. Patenaude.

Pt. 2. Core Examination and Drill Hole Temperatures, by E. Marshall and A. Gow.

Péwé, Troy L. Quaternary Glacial Geology of the McMurdo Sound Region, Antarctica; a Progress Report, 4 p.

NORTHERN HEMISPHERE PROGRAM

Sharp, Robert P. Investigation of Glacier Dynamics on the Blue Glacier, U. S. A., 4 p.

LaChapelle, E. R. Winter Snow Observations on Mt. Olympus, 5 p.

Meier, Mark F. Glacier Observations in the Cascade Mountains, U. S. A., 6 p.

Heusser, Calvin J. Lemon Creek Glacier, Juneau Ice Field Research Project, 4 p.

Field, William O. Observations of Glacier Behavior in Southern Alaska, 1957, 6 p.

Arctic Institute of North America. Glaciology Program for McCall Glacier, Brooks Range, Alaska, 23 p.

Sater, John C. Surface Motion Studies of the McCall Glacier, June to October, 1957.

Keeler, C. M. Ablation Studies: Lower McCall Glacier, June 23 to September 1, 1957.

Untersteiner, N., and Franklin I. Badgley. Preliminary Results of Thermal Budget Studies on Arctic Pack Ice During Summer and Autumn, 13 p.

Le Blanc, Robert G. Scientific Activities of the Terrestrial Sciences Laboratory of the Geophysics Research Directorate on Fletcher's Ice Island, T-3, 6 June 1957 to 25 September 1957, 6 p.

1-2458. IGY World Data Center A: Glaciology. OVERSNOW TRAVERSE PROGRAMS, BYRD AND ELLSWORTH STATIONS, ANTARCTICA, 1957-1958: SEISMOLOGY, GRAVITY, AND MAGNETISM, by Edward Thiel, Charles R. Bentley, Ned A. Ostenso, and John C. Behrendt: Its: Glaciolog. Rept. Ser., no. 2, variously paged, illus., maps (part fold.), profiles (part fold.), graphs (part fold.), tables, New York, American Geographical Society, July 1959, refs.

This volume is the second in a series of preliminary reports being issued by IGY World Data Center A: Glaciology (for the first report see above). Results of the Antarctic oversnow traverse program are being analyzed at the data reduction center of the University of Wisconsin under the directorship of Dr. G. P. Woollard, Dept. of Geology. Principal aim of the data center has been to compile a set of reports in convenient form for distribution to those who can make effective use of the information prior to final publication of the results. This volume contains the following 7 papers:

Thiel, Edward. Gravity Base Stations, Antarctica, 10 p.

Bentley, Charles R., and Ned A. Ostenso. Seismic Program on the Marie Byrd Land Traverses, 1957-1958; a Preliminary Report, 9 p.

Ostenso, Ned A., and Charles R. Bentley. Gravity and Magnetic Studies on the Marie Byrd Land Traverses, 1957-1958; a Preliminary Report, 47 p.

Ostenso, Ned A., and Charles R. Bentley. The Problem of Elevation Control in Antarctica, and Elevations on the Marie Byrd Land Traverses, 1957-1958, 26 p.

Thiel, Edward, and John C. Behrendt. Seismic Studies on the Filchner Ice Shelf, Antarctica, 1957-1958, 14 p.

Thiel, Edward, and John C. Behrendt. Gravity and Magnetic Measurements on the Ellsworth Oversnow Traverse, 1957-1958, 21 p.

Thiel, Edward, and John C. Behrendt. Seismic Studies at the Ellsworth Snow Pit, 14 p.

1-2459. Woodruff, James F., and Eldon J. Parizek. SOME COMMENTS ON STONE LINES - A REPLY: Prof. Geographer, v. 11, no. 5, p. 8-11, Sept. 1959, 4 refs.

C. N. Crain has concluded that stone lines are weathered *in situ* remnants of lenses or layers of rocks within the regolith which have resisted the deep weathering more successfully than the remainder of the layer (Association of American Geographers, Annals, v. 48, p. 257, 1958). Some facts which refute that conclusion are: stone lines are not essentially restricted to the regolith; stone lines in places are aligned in unconformable relation to the regional geology; the shape and composition of included stones is inconsistent with the underlying rock. Transportation of material is an essential step in the development of stone lines. --M. Russell.

1-2460. Crickmay, C.H. A PRELIMINARY INQUIRY INTO THE FORMULATION AND APPLICABILITY OF THE GEOLOGICAL PRINCIPLE OF UNIFORMITY: 50 p., 8 pls. inc. 5 illus., fold. map, 2 secs., diag., graph., privately pub., at E. deMille Books, Calgary, Alberta, 1959, 30 refs.

The geological principle of uniformity of cause and effect throughout the history of the earth has given rise to such collateral notions as that which denies geologic repose. The suspicion that this might involve inaccuracy demanded a study of field facts and their bearing on theory.

A concept called the controlled example is elaborated and, after several illustrations of it, an unusually serviceable example Nugget Mountain (British Columbia) - is indicated as an area of study. This is a deeply dissected plateau with small, flat upland remnants at several elevations preserving remarkable details, and with deep, V-shaped, terraced-walled valleys. Many facts of surface form, relation of surface to bedrock, and superficial lithic mantle are given.

An hypothesis that the area exhibits evidence of Pleistocene glaciation is found untenable, and it is concluded that only stream work and wasting have shaped most of this area. But both Davisian and Penckian geomorphogenic interpretations are contradicted by physical facts.

In view of the suggestion that difficulty in understanding Nugget Mountain may be due to lack of knowledge of the properties of geologic agents, the physics of running water is examined in its relation to geologic work. New terms - pinnacle flow, translatory and initiatory competence - are proposed. The principle of grade is examined and defined anew. Attention is called to near-grade - not hitherto understood - and its physical mechanism is unmasked. The effects of grade on sculpture of the earth by streams are studied at length; lateral corrasion by graded and near-graded streams is claimed to be the dominant surface process. The new term afflux level is proposed to replace local base level. The carving of gentle dip-slopes is termed forced slip-off erosion. The existence of approximate dip-slopes is indicated. Finally, the protracted evolution of surface form is ascribed to a long history of lateral action by streams. Among other conclusions, a new principle of erosional probability is developed. The discussion leads to recognition of active and stagnant surfaces - stagnancy being approximately geologic repose - and these ideas constitute an hypothesis of unequal activity.

Discussion returns to Nugget Mountain and interprets the various surfaces in terms of this new hypothesis. The flat uplands are panplains rather than peneplains; that which truncates Nugget Mountain is trenched by a very small, dry, shallow valley - the feature of the country that confirms geologic repose. It is further concluded that the valleys were eroded not by central down-cutting and lateral wasting, but by side-to-side oblique corrasion - the process that has concentrated the rich placer gold of the region.

Final proposals call for a cycle of denudation which is visualized as embracing an anagenetic stage during which erosion continues to be complicated by frequent renewals of diastrophism, and a catagenetic stage which begins when diastrophism has become quiescent and in which denudation progresses without diastrophic interference.

It is concluded that there are discrepancies in the intensity of superficial process of the order of at least 10 million to one. The most intense erosion is many times the mean for the surface of the United States obtained by Dole and Stabler in 1909; the least intense is approximately infinitesimal. This comprehends the limitation proposed for the principle of uniformity. --Auth.

1-2461. Burke, H.D., and A.W. Krumbach, Jr. NITROGEN PROBE FOR SOIL-MOISTURE SAMPLING: Jour. Geophys. Research, v. 64, no. 8, p. 1039-1042, 4 illus., graph, 2 tables, Aug. 1959, 3 refs.

Moisture determinations were made on soil cores frozen to hollow probes into which liquid N had been poured. Values compared closely with those from samples extracted by more conventional methods. --Auth.

1-2462. U.S. Soil Conservation Service. SOIL AND WATER USE IN THE SOVIET UNION. Report of a Technical Study Group: 50 p., illus., map, table, Washington, D.C., 1959

In 1958 the U. S. Dept. of Agriculture sent 6 technical study groups to the Soviet Union under an exchange-of-specialists agreement between the U. S. and U. S. S. R. Each study group prepared a report for publication. This report is that of the Soil and Water Use exchange group. The itinerary was selected to include the important agricultural regions of the U. S. S. R. and those with problems of drainage, irrigation, erosion, fertility maintenance, and new-land development. Areas included the Ukraine and from Moscow E. to the Tashkent and lake Balkash regions. Included in the report, in addition to other agricultural observations, are discussions of the soil classification, soil maps, and descriptions of soil types; laboratory research in soil science; soil management; erosion and soil blowing; soil conservation plans. --A. C. Sangree.

1-2463. Banks, Joseph E. LIMESTONE CONGLOMERATES (RECENT AND CRETACEOUS) IN SOUTHERN FLORIDA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 9, p. 2237-2243, 7 illus., sec., Sept. 1959, 11 refs.

We may speculate that summit conglomerates form during a regression of the sea just as naturally as basal conglomerates form during a transgression of the sea. Summit conglomerates can occur in any part of a sedimentary basin, but they are best developed on topographic features far from the mainland that protrude into the zone of agitated marine water. Of economic value is the generalization that summit conglomerates after burial become likely traps for oil and gas. --Auth. concl.

1-2464. Guilcher, André. COASTAL AND SUBMARINE MORPHOLOGY. Translated by B.W. Sparks, and R.H.W. Kneese: 274 p., 21 illus., 40 figs. incl. maps, secs., graphs, London, Methuen & Co.; New York, John Wiley & Sons, 1958, refs.

This translation is based on a revised edition of Morphologie Littorale et Sous-marine, first published in 1954 by Presses Universitaires de France. The present translation was first published in 1958. The book is divided into 2 parts: 1)coastal geomorphology and 2) an outline of submarine geomorphology. Subjects covered in Part I are: the forces in action - waves, currents, subaerial runoff, infiltration, and frost action, wind, chemical and biological processes; shoreline movements - eustatic movements, Quaternary tectonic and epeirogenic movements; coastal features related to sea action - cliffs and platforms, beaches and dunes, estuaries, marshes, and deltas, coral formations; classification of coasts - ria, fjord, glacial lowland, unglaciated lowland, and coasts dominated by structure; coastal evolution. This section occupies about 70% of the book.

Part 2 deals with the continental margin - extent and relief, nature and origin of the continental shelf and slope, neritic and bathyal sediments, relief origin, and evolution of submarine canyons; the deep-sea floor - relief and structure, ridges, seamounts, and tablemounts, trenches and associated features, pelagic deposits.

1-2465. Petrov, Victor P. SOVIET OCEANOGRAPHIC STUDIES UNDER THE IGY: Naval Research Rev., p. 16-26, 8 illus., Aug. 1959.

The Soviet Union may soon become the leader in oceanographic research. Their fleet includes 7 ships ranging from 1,500 to 6,000 tons and two 12,000-ton icebreakers.

Some of the ships engaged in IGY research and their areas of study included: the Vitiaz, which recorded depths and ocean bottom features in the Pacific; the Mikhail Lomonosov, Ekvator, and Sevastopol which studied the Atlantic; the Sedov, a nonmagnetic sailing ship; the Ob, Toros, and Poliarnik, - engaged in Arctic and Antarctic research; and, finally, the Severianka, a submarine specially equipped to make visual and television observations underwater. Discoveries included a new maximum deep of 34,057 ft. in the Kurile-Kamchatka deep, an extension of the Hawaiian underwater range, diatom soils in southern waters, magnetic anomalies in the Atlantic, and the discovery of several deep-water currents. --M. Russel.

1-2466. Shaw, Earl B. ANGLO-AMERICA: A REGIONAL GEOGRAPHY: 480 p., illus., maps, diags., graphs, New York, John Wiley & Sons; London, Chapman & Hall, 1959, approx. 400 refs.

Primary attention is given to the United States and Canada, but a chapter on Greenland is included. A preliminary chapter points out major geographic features of the continent, and in each succeeding chapter a description of the regional physical geography precedes analysis of regional activities. Emphasis is placed on land use. A list of questions and references follows each chapter.

Contents: North America, overview; Greenland; tundra of Canada and Alaska; taiga, or subarctic region of Canada; Middle Atlantic Coastal Plain; the Northeast; southwest Appalachians; interior seaboard; central farming region; the South; the Great Plains; the Rocky Mountains; intermontane plateaus; Pacific borderlands; North America, outlook. --A. C. Sangree.

3. STRUCTURAL GEOLOGY

See also: Areal and Regional Geology 1-2454; Geomorphology 1-2456; Geophysics 1-2514, 1-2518; Sedimentary Petrology 1-2566; Fuels 1-2642.

1-2467. Badgley, Peter C. STRUCTURAL METHODS FOR THE EXPLORATION GEOLOGIST: 278 p., 329 figs., 16 pls., 18 tables, New York, Harper & Brothers, 1959, 377 refs.

This book is designed to give a comprehensive coverage of structural methods and to demonstrate their application in petroleum and mineral exploration. Each chapter begins with a review of principles, illustrated by case histories. A group of problems follows, based on actual exploration projects, using maps and air photographs extensively. Complete up-to-date bibliographies are included to permit deeper study. Amply illustrated and written in a simple straightforward style, this book is thus valuable for professional explorers as well as students.

Subjects covered: descriptive geometry for structural geologists; structural projections on topographic maps; structural cross sections; structure contour maps; isopach maps as a guide to structures; isometric projections; fault problems; oil and ore reserve estimates in structural traps; stereographic projections; tectonic analysis in exploration. --Auth.

1-2468. National Academy of Sciences-National Research Council, Division of Earth Sciences, AMSOC Committee. DRILLING THRU THE EARTH'S CRUST. A STUDY OF THE DESIRABILITY AND FEASIBILITY OF DRILLING A HOLE TO THE MOHOROVICIC DISCONTINUITY: Natl. Acad. Sci.-Natl. Research Council, Pub. 717, 20 p., 2 secs., 4 diags., table, Sept. 1959, 6 refs.

The AMSOC Committee believes that it is both desirable and feasible to drill a hole completely through the earth's crust beneath the ocean. It is desirable because there seems to be no other way of obtaining unambiguous scientific information about the composition, age, and physical characteristics of the mantle and the deep crustal rocks. It is feasible because there are places where the Moho approaches within 9.5 km. of the sea surface. This depth appears to be within the reach of the best of modern drilling equipment. A program is proposed for obtaining the necessary data by drilling preliminary test holes, for designing and building a deep-drilling vessel, and for drilling to the Moho. --Auth.

1-2469. Meshcheryakov, Yu. A. CONTEMPORARY MOVEMENTS IN THE EARTH'S CRUST. Translated by Anita Navon: Internat. Geology Rev., v. 1, no. 8, p. 40-51, 3 illus., 4 maps, profile, diag., Aug. 1959, 8 refs.

Increased accuracy and volume of geodetic investigation, particularly precise repeated leveling, has made possible the study of secular land movements, the slow uplift and subsidence of the lithosphere. Many nations have engaged in level-measuring surveys which have resulted in the compilation of maps of contemporary crustal movements. Although many geodesists and geologists maintain that only certain parts of the earth's crust are mobile, there is not a single area of any consequence in which secular movements are absent. Contemporary movements, varying in direction and intensity, occur in mountainous regions, plains, and sea bottoms. These movements influence river patterns, shoreline configurations, and landscape forms in general. With increased precision and number of engineering projects, the consideration of secular movements becomes a necessary element in long-term planning of complex construction such as ports, pipelines, canals, irrigation systems, and hydroelectric stations. --G. E. Denegar.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

also: Geologic Maps 1-2429; Areal and Regional
logy 1-2434, 1-2451, 1-2454; Paleontology 1-2494,
512; Sedimentary Petrology 1-2558, 1-2564, 1-2569;
ls 1-2613, 1-2615, 1-2616, 1-2617, 1-2619, 1-2620,
621, 1-2624, 1-2631, 1-2633 through 1-2636, 1-2642,
647, 1-2648.

rrection: Geoscience Abstracts 1-1900 in v. 1,
8, Aug. 1959, should read Oklahoma Geol. Sur-
y, Guide Book 8, not Guide Book 7.

**2470. Connell, James F. L. HISTORICAL GEOL-
GY LABORATORY MANUAL FOR THE SOUTHERN
ATES: 143 p., Dubuque, Iowa, Wm. C. Brown
mpany, 1959.**

A laboratory manual developed around Southern
ology for use in colleges of the South. Unit 1. Study
fossils; Unit 2. Geologic maps; Unit 3. Exercises
the surface geology of the Southern states. --Geo-
mes, v. 4, no. 2, p. 30.

**2471. West Texas Geological Society, Midland
xas. Lexicon Committee. LEXICON OF PRE-
NNSYLVANIAN STRATIGRAPHIC NAMES OF WEST
EXAS AND SOUTHEASTERN NEW MEXICO: 153 p.,
maps, chart, 1958, approx. 150 refs.**

This alphabetical listing of 145 pre-Pennsylvanian
ratigraphic names includes the following informa-
on for each name: age, type locality, original author,
iginal definition, redefinition or history, lithologic
aracteristics, thickness and distribution, strati-
raphic position, correlation, references, and name
compiler. --M. Russell.

**2472. Wahlstrom, Ernest E., and Ok Joon Kim.
RECAMBRIAN ROCKS OF THE HALL VALLEY
REA, FRONT RANGE, COLORADO: Geol. Soc. Am-
ica, Bull., v. 70, no. 9, p. 1217-1244, 4 illus. on
pls., 2 maps (1 fold.), fold. secs., fold. chart, 4
ags., 14 equal-area plots, 4 tables, Sept. 1959,
refs.**

The Hall Valley area, in northwestern Park County,
lorado, contains foliated high-grade Precambrian
etamorphic rocks resulting from recrystallization
a complexly folded and faulted clastic sedimentary
quence containing 2 series of strata separated by
angular unconformity of regional extent. Some of
e metamorphic rocks were further modified by mig-
atization and granitization, which seem to have fol-
wed an interval of extensive faulting and dislocation
the previously metamorphosed rocks. Field and
oratory data for rocks outside areas of extensive
igmatization and granitization indicate the fabric,
mposition, and probable manner of deposition of the
dimentary layers that were present before meta-
orphism and provide an argument against continued
e of the terms Idaho Springs formation and Swan-
ke gneiss for the metasedimentary rocks of the
ll Valley area.

The history of the foliated metamorphic rocks and
later migmatites and granitic rocks is interpreted
follows: 1) Deposition of a thick series of quartz-
e sandstones, arkoses, shales or mudstones, and
nestones was terminated by uplift and gentle fold-
and the development of an extensive erosion sur-
e. 2) Sedimentation resumed, and a thick, lenticu-
sequence of clastic quartzo-feldspathic sedimen-
y rocks intercalated with abundant clastic mate-
ls of probable basaltic composition was deposited over the unconformity. 3) Mafic dikes and sills were intruded into the sedimentary rocks during an interval that may have overlapped the time interval of deposition of the sedimentary rocks above the unconformity. 4) Deformation produced NW.-trending folds and was accompanied in its later stages by elevation of temperature and recrystallization of the sedimentary and igneous rocks into high-grade metamorphic rocks. 5) After a time interval of unknown duration the rocks were again dislocated along a fault of considerable displacement and NE. strike, almost at right angles to the previously formed NW. structures. 6) Migmatization and granitization later than the fault resulted from pervasive metasomatism SE. of the fault and to a lesser extent NW. of the fault. Metamorphic rocks outside the areas of migmatization show mild retrogressive changes, possibly caused by widespread penetration of solutions generated during migmatization and granitization. 7) A body of Boulder Creek granodiorite was intruded into the NE. portion of the Hall Valley area. Although the granodiorite appears to cut across the fabric of the migmatites and granitic rocks, it may be genetically related to them. 8) The area was intruded by several dikes and irregular bodies of felsic rocks that probably are related to similar rocks of Tertiary age elsewhere in the Front Range. --Auth.

1-2473. Sanford, B.V., and R.G. Quillian. SUBSURFACE STRATIGRAPHY OF UPPER CAMBRIAN ROCKS IN SOUTHWESTERN ONTARIO: Canada, Geol. Survey, Paper 58-12, 29 p., 6 maps (2 in pocket scale 1:1,013,760), secs. (in pocket), 2 tables, 1959, 24 refs.

Upper Cambrian rocks underlie parts of Lake Erie, Lake Huron, and nearby regions of southwestern Ontario. They rest unconformably on an irregular Precambrian surface and are only known from boreholes. Correlations are made with surface and subsurface occurrences in the United States. Upper Cambrian beds are assigned to Mount Simon, Potsdam, Eau Claire, Theresa, Trempeleau, and Little Falls formations. Structure is controlled by the Algonquin arch, Findlay arch, and the "Chatham sag." In addition to noncommercial shows, 2 wells have produced oil and gas from strata of probable Upper Cambrian age. Appendix gives stratigraphic and production data for 196 wells. Maps and figures show lithology, isopachs, and correlations. --P. Harker.

1-2474. Reso, Anthony, and Carey Croneis. DEVONIAN SYSTEM IN THE PAHRANGAT RANGE, SOUTHEASTERN NEVADA: Geol. Soc. America, Bull., v. 70, no. 9, p. 1249-1252, illus., map, sec., Sept. 1959, 6 refs.

The maximum composite thickness of the Devonian system in the Pahranagat Range is approximately 6,048 ft., divided into 5 formations: Sevy, Simonson, Guilmette, West Range limestone, and Pilot shale. It contains faunal zones which should facilitate regional correlation. --M. Russell.

1-2475. Hayes, Philip T. SAN ANDRES LIMESTONE AND RELATED PERMIAN ROCKS IN LAST CHANCE CANYON AND VICINITY, SOUTHEASTERN NEW MEXICO: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 9, p. 2197-2213, 2 illus., 2 maps, secs., 2 diags., Sept. 1959, 24 refs.

The Last Chance Canyon area of southwestern Eddy County, New Mexico, exhibits relations between the Permian strata that are of regional geologic significance. Recent mapping suggests that some interpretations of the age relations of the San Andres limestone and overlying units should be modified. Intertonguing between the upper part of the San Andres and the sandstone tongue of the Cherry Canyon formation (middle Guadalupe series) is well displayed in Last Chance Canyon. These 2 units unconformably overlie rocks of latest Leonard and/or earliest Guadalupe age that are correlated with the lower part of the San Andres of areas on the N. and W. In the Big Dog Canyon scarp a few miles W., the rocks of Cherry Canyon age are apparently separated from rocks of latest Leonard and/or earliest Guadalupe age by more than 579 ft. of carbonate rocks which are considered equivalent in age to the Brushy Canyon formation (early Guadalupe age) of the Delaware basin. The sequence within the San Andres limestone in Big Dog Canyon may therefore represent nearly continuous deposition from latest Leonard and/or earliest Guadalupe time into Cherry Canyon time.

The San Andres limestone is overlain by the Grayburg formation which is equivalent to the Grayburg formation of subsurface usage. The Grayburg formation and overlying Queen formation are laterally equivalent to the Goat Seep limestone and thus of middle Guadalupe age. --Auth.

1-2476. Hose, Richard K. and Charles A. Repenning. STRATIGRAPHY OF PENNSYLVANIAN, PERMIAN, AND LOWER TRIASSIC ROCKS OF CONFUSION RANGE, WEST-CENTRAL UTAH: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 9, p. 2167-2196, map, 5 secs., Sept. 1959, 24 refs.

Work by the U.S. Geological Survey in the Confusion Range of W.-central Utah during the past few years has resulted in the accumulation of considerable data regarding the stratigraphy of rocks ranging in age from Late Mississippian through Early Triassic. These rocks are here discussed as 6 formations, whose physical limits more or less coincide with the boundaries selected by earlier workers in the area, although considerable changes in stratigraphic nomenclature have been made.

The Ely limestone of Late Mississippian, Early and Middle Pennsylvanian, and Permian age consists of 1,850-2,000 ft. of alternating resistant thick-bedded limestone and slabby slope-forming limestone. The upper 100-350 ft. of the formation contains an early Permian fauna and is generally more massive and less cherty than the remainder of the formation, which contains a fauna characteristic of the lower half of the Pennsylvanian and locally Late Mississippian. A hiatus representing Late Pennsylvanian time separates Middle Pennsylvanian and Permian faunas.

The Arcturus formation, which conformably overlies the Ely limestone, consists of poorly indurated yellowish-gray calcareous sandstone with thin, ledge-forming interbeds of dark gray to tan limestone and dolomite. The few fossils found in the Arcturus formation, and its stratigraphic position, suggest that the formation is early to middle Permian in age. The total thickness of the formation is uncertain, but a minimum thickness of 2,700 ft. has been measured.

The succeeding 3 formational units, the Kaibab limestone, the Plympton formation (new name), and the Gerster limestone, all of Permian age, have been included in the Park City group.

The Kaibab limestone overlies the Arcturus formation and consists of 480 ft. of somewhat cherty bioclastic limestone. The lithologic character of the Kaibab is in sharp contrast to the succeeding unit which is here named the Plympton formation and is predominantly dolomite and chert. The Plympton formation is 690 ft. thick and contains phosphatic beds believed to be lithologic correlatives with parts of the Park City formation of northwestern Utah. Th overlying Gerster limestone consist of 1,100 ft. of very fossiliferous cherty bioclastic limestone and argillaceous limestone. The Gerster limestone is the youngest Permian unit in the Confusion Range. Like the Kaibab, it is differentiated from the Plympton formation by its high limestone content and lack of dolomite. The contact between the Plympton and the Gerster limestone is conformable throughout the area. The Kaibab limestone, the Plympton formatio and the Gerster limestone are believed to be correlative with units within the Park City and related formations of nearby areas in northern and northwester Utah and northeastern Nevada. In areas S. of the Confusion Range, the younger Permian units, the Plympton formation, and the Gerster limestone, are absent and only the Kaibab limestone is present in the Grand Canyon area.

The Thaynes formation of late Early Triassic age consists of thick beds of predominantly greenish-gray calcareous clay shale interbedded with thin bed of gray to chocolate brown limestone, and is more than 1,900 ft. thick in the Confusion Range. It is unconformably overlain by Tertiary and Quaternary strata, and no younger Mesozoic rocks crop out in the area. The contact of the Thaynes formation with the underlying Gerster limestone appears conformable; however, faunal evidence indicates a considerable hiatus between the 2 formations. --Auth.

1-2477. Tipper, H.W. REVISION OF THE HAZELTON AND TAKLA GROUPS OF CENTRAL BRITISH COLUMBIA: Canada, Geol. Survey, Bull. 47, 51 p., 5 maps (1 in pocket, scale 1:506,880), 2 secs., chart, 1959, 47 refs.

In recent years most of the Mesozoic rocks of ce tral British Columbia have been assigned to one or other of 2 groups, the Hazelton and the Takla. The limits of these 2 groups had, however, not been precisely defined, and in practice there had been much confusion as to the position of the mutual boundary. In Nechako River map-area the Mesozoic rocks fall naturally into 2 groups which clearly correspond to the Takla and Hazelton. The Takla is an assemblag of volcanic and sedimentary rocks with locally a red bed facies. Fossils have been collected from 2 horizons, one collection being of late Triassic age and one of Jurassic, probably early Jurassic.

At the close of the Takla episode an important change occurred in the configuration of the marine depositional basin, and the next rocks in the succession are characterized over a wide area by chert pebble conglomerate. This change and the unconfor ity which is present at least locally is considered to mark the break between the Takla and Hazelton groups, and the chert pebble conglomerate unit is considered to define the base of the Hazelton. The Hazelton group in this area apparently ranges from earliest Middle Jurassic to early Upper Jurassic. There is no evidence to suggest that deposition was continuous over this period of time at any one place; on the contrary, it is considered probable that diastems and disconformities are present. --H. M. A. Rice.

1-2478. Frebold, Hans. MARINE JURASSIC ROCKS IN NELSON AND SALMO AREAS, SOUTHERN BRITISH COLUMBIA: Canada, Geol. Survey, Bull. 49, 31 p., 5 pls., 2 maps, table, 1959, 27 refs.

The marine fossils hitherto found in Nelson, Salmo, and Caribou Creek areas indicate the presence of 3 subdivisions of the Jurassic system. The ammonites (Arnioceratids) found in Archibald Creek, in the coquina bed on the ridge NE. of Parks, Beaver Creek, and in the Caribou Creek area 6 mi. NE. of Burton, Lower Arrow Lake, all indicate a Sinemurian (early Lower Jurassic) age for the rocks concerned. The Harpoceratids in the upper part of the Elise formation, found between Hall and Porto Rico, suggest a Toarcian (late Lower Jurassic) age, and the questionable Sonninia and other Harpoceratids found in the Hall formation, 2.7 mi. SW. of Porto Rico station, probably belong to the Bajocian (lower Middle Jurassic)...

The presence of marine Jurassic rocks in Nelson, Salmo, and Caribou Creek areas, and the great thickness of the formations concerned, prove the existence of a Jurassic geosynclinal sea in this area which was previously considered to be part of a geanticlinal landmass "Jurozephyria." The writer has shown that reasons previously given in favor of such a landmass do not hold. Volcanic islands, however, probably existed in this area at different times during the Jurassic period. The near-shoreline or shallow-water character of some of the sediments, for instance the coquina bed NE. of Parks, may be explained by the presence of such islands.

The distribution of these thick marine deposits is, as shown by Little and others, restricted. This may be explained, at least partly, by the transition of these deposits into more highly metamorphosed rocks. Thus, Little considered it possible that the Hall formation is replaced northeastward by gneisses. --Auth. summ.

1-2479. Zamarayev, S.M., and G.R. Kolosnitsyna. NEW DATA ON THE STRATIGRAPHY OF MESOZOIC SEDIMENTS IN THE WESTERN TRANSBAIKAL REGION. Translated by Salih Faizi: Internat. Geology Rev., v. 1, no. 8, p. 79-83, 2 secs., Aug. 1959, 6 refs.

Continued mineral exploration in western Transbaikal [U.S.S.R.] has resulted in further stratigraphic investigation of Mesozoic sediments in that area. Martinson, on the basis of fauna collected, assigned the Gusino-Ozersk bituminous shales to the middle of the Lower Cretaceous. Stratigraphically and paleontologically, the shales, containing a large number of phyllopods, insects, and fish, resemble transitional Upper Jurassic-Lower Cretaceous Mongolian sediments. It is possible that the boundary between the Jurassic and Cretaceous in this region is not a line, but a transitional zone of apparently small width. --G. E. Denegar.

1-2480. Shikama, Tokio. THE QUATERNARY PERIOD IN MANCHURIA: Translated by Riuji Endō: Internat. Geology Rev., v. 1, no. 8, p. 14-39, 6 figs. incl. map, illus., secs., 3 tables, Aug. 1959, 42 refs.

The Quaternary system of Manchuria is composed, generally speaking, of 3 facies: the N. China loess, the Mongolian eolian, and the Manchurian flood-plain lacustrine. A piedmont facies is developed in the mountain district, and basaltic plateaus are also extensively distributed.

The complete formation of the Hei-liao divide was in the Lao-ho stage (chronologically between the Malan stage of the upper Diluvium and the black-earth stage of the Alluvium). Its slow upheaval may correspond with terrace movements of Du_1 plane in the islands of Japan. It is also related to the tilting movement of the Korean peninsula.

The Ku-hsiang-t'un formation is rich in fossils, including plants, mollusks, insects, fish, reptiles, birds, mammals, and others. Culture of stone implements of the Ku-hsiang-t'un formation is Mousterian to Magdalenian. Three human skulls (the Djalainor man) were found.

Some relationship may exist between the permanently frozen sediments of the Ta-hsing-an-ling Shan Mo and the Würm glacial stage of Europe or the Wisconsin glacial stage of North America. --G. E. Denegar.

1-2481. Reber, Grote. AGE OF LAVA FLOWS ON HALEAKALA, HAWAII: Geol. Soc. America, Bull., v. 70, no. 9, p. 1245-1246, 4 illus., map, table, Sept. 1959, ref.

The age of lava flows on the SW. side of Haleakala, Maui, Hawaii, are dated on the basis of historical records and C^{14} analysis. The flow of Kalua o Lapa occurred 200 ± 15 years ago; Makua, 590 ± 120 years ago; Keonehunehune, 650 ± 140 years ago; and Kamahina, 890 ± 170 years ago. --M. Russell.

5. PALEONTOLOGY

See also: Stratigraphy 1-2478.

1-2482. Shaver, Robert H. ADVENTURES WITH FOSSILS: Indiana, Geol. Survey, Circ. 6, 52 p., illus., 1959.

Many laymen write to the Indiana Geological Survey and ask for books and maps on fossils. This circular is written for laymen, but especially for those of school age. It is for school teachers, scoutmasters, parents, and other counselors of children. It is a beginner's guide to fossils, most useful to collectors in Indiana. It is for the curious everywhere who seek a hobby, avocation, or beginning knowledge to a profession. --From Auth. pref.

1-2483. Crow, James F. IONIZING RADIATION AND EVOLUTION: Sci. American, v. 201, no. 3, p. 138-160, 4 illus., chart, 4 diags., Sept. 1959.

Living things evolve as a result of random mutations in hereditary characteristics that survive when they make the organism more fit. The role that ionizing radiation plays in the evolutionary process appears to be a minor one. The over-all mutation rate is not determined by radiation to any significant extent. Paleontological examples of rapid evolution, such as the horse, and slow evolution, such as the horseshoe crab and opossum are cited in drawing the conclusion that natural selection and not ionizing radiation is the principal factor in evolution. --M. Russell.

1-2484. McLaren, D.J. A REVISION OF THE DEVONIAN CORAL GENUS SYNAPTOPHYLLUM SIMPSON: Canada, Geol. Survey, Bull. 48 (Contributions to Canadian Palaeontology), p. 15-33, pls. 7-10, 10 illus., 1959, 46 refs.

Interpretation of this genus has long been in a state of great confusion. As a result of this study all but one of the species ascribed to it were found to differ so markedly from the type species that a new generic name is proposed for them. Also ascribed to the original genus were several specimens that do not belong to it and differ even from the spcies in which they have been placed. For these the author proposes new names and a different generic affiliation. --P. Harker.

1-2485. Woodring, W.P. GEOLOGY AND PALEONTOLOGY OF CANAL ZONE AND ADJOINING PARTS OF PANAMA. DESCRIPTION OF TERTIARY MOLLUSKS (GASTROPODS: VERMETIDAE TO THAIDIDAE): U.S. Geol. Survey, Prof. Paper 306-B, p. 147-239, 14 pls., Aug. 1959, 167 refs.

The description of the mollusks found in the Tertiary deposits of the Canal Zone and adjoining parts of Panama - ranging in age from middle and late Eocene to early Pliocene - started in Chapter A, is continued in the present chapter. A total of 104 species and subspecies in 17 families of gastropods (and 7 additional species in 4 families already covered in Chapter A - U. S. Geol. Survey, Prof. Paper 306-A) is considered. Ninety-three are formally described under separate headings; the other 18, all represented by inadequate material, are briefly described or merely mentioned.

Notable fossils from the Gatuncillo formation, of middle and late Eocene age, include Dirocerithium ame (a species of a new genus, evidently of Tethyan affinities, that reached southeastern United States during middle Eocene time), Oostrombus aff. O. chiraensis, Terebellum (Terebellum) procerum?, T. (Seraphs) belemnitum?, Ectinochilus cf. E. gaudichaudi, Morum ("Oniscidia") sp. (the earliest known American species of "Oniscidia"), and Yasila aff. Y. paytensis.

The late Eocene or early Oligocene marine member of the Bohio(?) formation has both Eocene and Oligocene faunal affinities, as shown by Architectoica aff. A. alveata, A. cf. A. fungina, Morum cf. M. antiquum, and Typhis aff. T. curvirostratus.

The Bohio formation of Barro Colorado Island, where only the upper part of the formation is exposed, yielded fossils of late Oligocene age, including Hemisinus oeciscus, Turritella listrota (which seems to be the earliest known species of the T. ocoyana group), Orthaulax cf. O. pugnax, and Gonosycon epomis (the type of a new ficid genus). Orthaulax is an extinct endemic American genus that has an age range of late Oligocene to early Miocene. Orthaulax cf. O. pugnax also occurs in deposits of late Oligocene age in the Caimito formation of the Gatun Lake area and in the late Oligocene part of the Caimito formation of Madden basin, as well as in the upper part of the Bohio. Orthaulax cf. O. aguadillensis is found in the Culebra formation proper and in its Emperador limestone member, both of early Miocene age.

The upper Oligocene Caimito formation of the Gatun Lake area contains Ampullinopsis spenceri. Ampullinopsis is widely distributed in the Oligocene of western Europe. southeastern United States, the Caribbean region, Central America, and northern South America, but recently has been found in the middle or upper Eocene of Florida.

Potamides suprasulcatus, which occurs in the lower Miocene Culebra formation, is found in the Dominican Republic, along the south border of the Caribbean Sea from Trinidad to Columbia, and also in Ecuador and Peru. Its age range is late Oligocene to middle Miocene.

A new locality in the lower Miocene Cucaracha formation yielded fresh-water snails (Hemisinus aff. H. oeciscus), a crocodile tooth, turtle fragments, an incomplete mammal femur, and minute oögonia of a charophyte (Tectochara aff. T. escheri).

Almost half of the fossils described in the present chapter (44 species and subspecies) are from the richly fossiliferous middle Miocene Gatun formation. They include 2 species now living in both the Caribbean Sea and the eastern Pacific Ocean (Architectonica noblis and Murex recurvirostris); genera, subgenera and an unnamed species group that are no longer in the Caribbean Sea but survive in the eastern Pacific Ocean (Astronacus, Ochetoclava, Malea, group of Ficus ventricosa and Cymia); and a genus (Sconsia) that formerly lived in both the eastern and and the western Pacific Ocean but survives in the Caribbean Sea. Eupleura thompsoni is the first Caribbean species of the genus to be described.

The Chagres sandstone proper, of early Pliocene age, is noteworthy for its relatively large number of epitonids: species of Epitonium,Sthenorytis, and Scalina. The fossils of the Chagres also include Bathygalea hadra, a species of a recently described moderately deepwater and deepwater cassid genus.

The 202 forms covered in Chaps. A and B are estimated to be less than a third of the total available molluscan fauna to be described. --Auth.

1-2486. Parker, Robert H. MACRO-INVERTEBRAT ASSEMBLAGES OF CENTRAL TEXAS COASTAL BAYS AND LAGUNA MADRE: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 9, p. 2100-2166, 40 maps, 4 secs., 6 pls., 2 tables, Sept. 1959, 48 refs.

A study of the distribution of macrofauna and the ecological factors affecting their distribution in the bays and lagoons of the central and S. Texas coast has made it possible to formulate a series of criteria for interpreting modern and ancient depositional environments. The observations reported in this paper cover a 7-year period. In addition, some information was available covering a period of 30 years. The central Texas bays are situated in a variable climate, and the faunas reflect long-term changes in rainfall and temperature.

Four major environments are recognized on the basis of macro-invertebrate assemblages: 1) river-influenced low-salinity bays and estuaries characterized by Rangia and amnicolids; 2) enclosed bays, dominated by oyster reefs composed of Crassostrea virginica; 3) open bays and sounds characterized by Tagelus divisus, Chione cancellata, and Macoma constricta; and 4) bay and lagoon regions strongly influenced by inlets characterized by a mixed Gulf and bay fauna. Smaller "sub-facies" needing more information for recognition are 1) bay margins, 2) oyster reefs exhibiting marine influence, 3) bay centers, an 4) shallow grassy bays in the vicinity of inlets.

Five assemblages were recognized in Laguna Madre which are related to the physiography of the Laguna Madre: 1) shallow hypersaline area near inlet characterized by forms common to the Gulf and normal salinity bays on the N.; 2) open hypersaline lagoon characterized by Amygdalum papyria and other forms attaching to vegetation; 3) enclosed hypersaline lagoon with tremendous numbers of 2 pelecypods, Anomalocardia cuneimeris and Mulinia lateralis; 4) relatively deep hypersaline bay with clayey substrate with virtually no living macro-invertebrates; and 5) hypersaline lagoon with normal bay influence occupied by many of the species typical of an open bay plus Anomalocardia and Mulinia.

The application of macrofaunal assemblages to the interpretation of older sediments was demonstrated in a study of a series of borings taken in the Rockport area. The macrofaunal evidence indicates that the Rockport bays have undergone at least one marine transgression in the past 9,000 years. --Auth.

1-2487. Churcher, C.S. FOSSIL CANIS FROM THE TAR PITS OF LA BREA, PERU: Science, v. 130, no. 3375, p. 564-565, table, Sept. 4, 1959, 4 refs.

New fossil material has been obtained from La Brea, Peru. Included in this material are remains of a large wolflike canid which could not be referred to any living or fossil South American canine genus. Comparison with fossil canids from Rancho La Brea, California, shows that it closely resembles Canis (Aenocyon) dirus Leidy. --Auth.

1-2488. Reinhart, Roy H. A REVIEW OF THE SIRENIA AND DESMOSTYLIA: California, Univ., Pubs. Geol. Sci., v. 36, no. 1, p. 1-145, 14 pls., map, 14 illus., 3 diags., chart, 1959, 118 refs.

This study consists of 2 parts. Part I describes recent discoveries in the order Sirenia, in Colombia, Puerto Rico, Mexico, California, and Egypt. Part II pertains to a reevaluation of all desmostylid fossils from the Pacific coast of North America and Japan, with a description of many new specimens from California.

Part I: All sirenian fossils reported from the E. and the W. coasts of North America, from the Caribbean and the W. coast of Mexico are reviewed, and the more important European and Egyptian specimens are compared with the western hemisphere forms. From this study it is indicated that the family Dugongidae has had a world-wide distribution and has shown a moderate diversity of form as compared to the family Trichechidae which to date has been found only in the Caribbean and its environs. As yet no definite evidence has been found to substantiate nor completely repudiate the old concept of the origin of Trichechus in the Caribbean and Dugong in the Mediterranean. Present knowledge indicates that the trichechids have been a separate phyletic line from the dugongids since Eocene time.

Separation of the family Dugongidae into 2 phyletic lines starting with the middle Eocene Eotheroides is suggested. This division is based on the nasal-frontal relationship. One line is considered to have given rise to Halitherium in which the nasals meet in the mid-line whereas the other line gave rise to Caribosiren with the nasals separated by the frontals.

A further modification in classification is proposed in that the recently extinct, edentulous Hydrodamalis is believed to have been on a direct line of descent from the very large Miocene Halianassa from California.

Part II: Because of the paucity of desmostylid specimens, particularly postcranial elements, the designation of relationships of the desmostylids with other mammalian orders has been obscured. Knowledge gained from newly discovered desmostylid postcranial elements suggests that the present classification of the Desmostyliformes in the order Sirenia is inconsistent with the evidence. It is proposed that the genus Desmostylus and other desmostylids be placed in a taxonomic category or ordinal rank, the Desmostylia. The order Proboscidea, Sirenia, and the newly proposed order Desmostylia are considered to have descended from a common paenungulate origin, to have inherited many homologous characters, and to have retained or developed similar habits and environmental preferences. --Auth.

1-2489. Pierce, Richard L. CONVERTING COORDINATES FOR MICROSCOPE-STAGE SCALES: Micropaleontology, v. 5, no. 3, p. 377-378, table, July 1959, 4 refs.

Faulty explanations of coordinate conversion procedure have obscured the fact that a reference point in any location on a microscope slide permits cited coordinates to be quickly converted arithmetically despite vagaries of microscope-stage scale construction. --Auth.

1-2490. Pocock, Stanley A.J. SCALES FOR MAKING DIRECT MEASUREMENTS FROM PHOTOMICROGRAPHS: Micropaleontology, v. 5, no. 3, p. 349-350, illus., July 1959.

Directions are given for constructing a set of scales which may be overlaid on photomicrographs to enable direct readings of vector quantities. As a separate scale is required for each objective, the author recommends making a set of scales for all the objectives of a given microscope-camera combination to be kept with the microscope. Relatively inexpensive to construct, these scales make photomicrographs far more desirable for studying acid-insoluble microfossils. --L. M. Dane.

1-2491. Funkhouser, John W., and William R. Evitt. PREPARATION TECHNIQUES FOR ACID-INSOLUBLE MICROFOSSILS: Micropaleontology, v. 5, no. 3, p. 369-375, 2 figs., July 1959.

Several techniques useful in the preparation of spores, pollen, hystrichospherids, and similar acid-insoluble microfossils are described. These include oxidation treatments to remove unwanted organic matter; 4 aids in the mechanical separation of organic and mineral matter; and 2 methods for making permanent slides using cover-glass smears. A feature of all of these techniques is that the residues are retained in a water-base medium throughout processing. --Auth.

1-2492. Lankford, Robert R. DISTRIBUTION AND ECOLOGY OF FORAMINIFERA FROM EAST MISSISSIPPI DELTA MARGIN: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 9, p. 2068-2099, illus., 9 maps, sec., chart, 3 pls., 3 tables, Sept. 1959, 29 refs.

Equal volume surface sediment samples from the eastern delta margin were studied for Foraminifera. Six faunal assemblages, based on living specimens are defined: 1) marsh, 2) interdistributary bay, 3) fluvial marine, 4) deltaic marine, 5) sound, and 6) open shelf. Bottom-water masses, characterized by limits of variability of the chemical and physical properties, coincide with the faunal distribution. No single property of the bottom water appears to be the controlling ecological factor. There does not seem to be any causal relation between faunas and sediment characteristics; both appear to result from other processes active in a deltaic environment. Maximum living populations are associated with the high sedimentation rates of the prograding delta front. The smallest standing crops occur where sedimentation rates are low. The total number of Foraminifera per sample ranges from 150 to 34,000 specimens, and the maximum population zone is related to the area of highest foraminiferal productivity. Living and total counts are qualitatively similar except in areas where mud lumps containing relatively deep-water species are being eroded into shallow interdistributary bay deposits. Ratios of the living and total populations generally reflect effects of sedimentation. --Auth.

1-2493. Reiss, Z. THE WALL-STRUCTURE OF CIBICIDES, PLANULINA, GYROIDINOIDES, AND GLOBOROTALITES: Micropaleontology, v. 5, no. 3, p. 355-357, illus. on pl., July 1959, 5 refs.

An examination of specimens of Cibicides, Gyroidinoides and Globorotalites from the Upper Cretaceous of Germany and France and of Planulina from the Pliocene of Italy shows them to have primarily double-layered septa and thus to belong to the superfamily Bilamellidea. The species examined have been described by Hofker to have single-layered septa. The late Cretaceous species of Cibicides examined have granular-calcareous walls and not agglutinated ones, as stated by Hofker, and belong to the "lamellar" group of Foraminifera. Sixteen photomicrographs illustrate the features discussed. --Auth.

1-2494. Sen Gupta, Barun. ZONES OF THE PALEOGENE OF LAKHPAT, NORTHWESTERN KUTCH, INDIA: Micropaleontology, v. 5, no. 3, p. 365-368, map, table, July 1959, 13 refs.

The Paleogene of Lakhpat [23°50'N. 68°47'E.] in northwestern Kutch occurs in several mappable zones, distinguished primarily on the basis of the larger Foraminifera. The strata are mostly horizontal or subhorizontal, and the areal distribution of the zones is mainly controlled by topography. These are zones of marine regression, and nowhere has a great thickness been attained. --Auth.

1-2495. Drooger, C.W., and J. Magné. MIOGYPSINIDS AND PLANKTONIC FORAMINIFERA OF THE ALGERIAN OLIGOCENE AND MIOCENE: Micropaleontology, v. 5, no. 3, p. 273-284, map, 5 secs., chart, 2 pls., July 1959, 32 refs.

The scattered data on the Miogypsinidae in Algeria are reviewed, and their relationships with the planktonic Foraminifera of the Oligo-Miocene are established. The main points of this correlation are found to conform to earlier assumptions established elsewhere. The stratigraphic succession of the miogypsinid species is compared with that in other regions of the western Mediterranean. --Auth.

1-2496. Burma, Benjamin H. ON THE STATUS OF THEOCAMPE HAECKEL, AND CERTAIN SIMILAR GENERA: Micropaleontology, v. 5, no. 3, p. 325-330, July 1959, 16 refs.

This paper is a revision of the generic nomenclature of a few radiolarian genera whose species are good zone and index fossils. The following genera are revised more or less extensively: Sethamphorus, Sethocephala, Dictyocephalus, Theocampe, and Tricolocampe. The following names are reduced to synonomy: Dictyocryphalus, Cryptocephalus, Dictyoprora (1882), Platycryphalus, Dictyoprora (1887), Theocamptra, Theocampana, Tricolocampium, Tricolocamptra, and Theocampula. Diabolocampe is described as a new genus. --Auth.

1-2497. Riedel, William R. OLIGOCENE AND LOWER MIOCENE RADIOLARIA IN TROPICAL PACIFIC SEDIMENTS: Micropaleontology, v. 5, no. 3, p. 285-302, map, diags., 2 pls., 2 tables, July 1959, 18 refs.

Twenty-one species of Radiolaria, 10 of them new, are investigated in 17 Oligocene and lower Miocene samples from the Caribbean and tropical Pacific regions. It is possible to correlate sediments from the 2 regions approximately, on the basis of their radiolarian assemblages. Two series of species believed to show evolutionary sequences are discussed. --Auth.

1-2498. Hampton, John S. STATISTICAL ANALYSIS OF HOLOTHURIAN SCLERITES: Micropaleontology, v. 5, no. 3, p. 335-349, 2 illus., diag., illus. and graphs on 4 pls., July 1959, 38 refs.

The classification at present applied in the study of fossil holothurian sclerites is briefly outlined, and a major difficulty in the selection of valid criteria for the "speciation" of such microfossils is discussed. Groups of morphologically similar sclerites (morphogroups) derived from the Recent holothurians Holothuria impatiens (Forskāl) and Cucumaria saxicola Brady and Robertson are subjected to statistical analysis by standard univariate and bivariate techniques. The results are discussed in detail, and broad conclusions are drawn as to the application of statistical methods as an objective basis for the taxonomy (qua parataxonomy) of fossil morphogroups. A less rigid approach to the concept of the "type specimen" of the "species" is recommended. --Auth.

1-2499. Kremp, G.O.W., H.T. Ames, and Hilde Grebe. CATALOG OF FOSSIL SPORES AND POLLEN. VOLUME 1. CRETACEOUS AND TERTIARY SPORES AND POLLEN: 192 p., illus., University Park, Pennsylvania, Pennsylvania State University, College of Mineral Industries, Dept. of Geology, Palynological Laboratories, 1957, refs.

The purpose of the catalog is to help alleviate the threat of taxonomic chaos in the field of palynology and to enable palynologists to keep up-to-date files of descriptions of fossil pollen and spores. The increasing value of fossil pollen and spores in geology and the consequent rapid growth of this field, particularly since 1952, has resulted in a vast amount of literature published at the rate of 2 articles a week in over 200 journals throughout the world. Because of the speed at which new species are being and have been described - about 11 a week - much duplication of effort, taxonomic synonomy, and multiplicity of descriptive terms has led to misunderstanding and misinterpretation among palynologists.

Each volume of the catalog, then, is concerned with taxonomic and stratigraphic studies of dispersed spores older than Pleistocene, and contains descriptions of effectively published species. Photocopies of the original descriptions and half-tone copies of the original photos are reprinted. Other information included for each species is the original reference, geography and geology of the source site, and information concerning the type specimen (in English). Each volume contains a generic-specific index.

The catalog is available in 3 options: 1) plain index cards (8 1/2" x 11"); 2) "keysort" punch cards (8" x 10"); 3) punched sheets (8 1/2" x 11") in loose leaf binder. Until now 8 volumes have appeared, contents of which are listed separately. It is hoped that within about 5 years the catalog will be abreast of publications, at which time a glossary of morphologic terms used in palynology, a combined index, a morphologic coding system for the classification of the published spores and pollen, as well as translations of the descriptions will be prepared. --G. O. W. Kremp.

Contents v. 1:

Traverse, A., 1955. Pollen Analysis of the Brandon Lignite of Vermont, p. 1-52, 52 new species descriptions.

Wodehouse, R.P., 1933. Tertiary Pollen-II. The Oil Shales of the Eocene Green River Formation, p. 53-93, 41 new species descriptions.

Potonié, R., 1931. Pollenformen aus tertiaeren Braunkohlen, (3. Mitt.), p. 94-122, 29 new species descriptions.

Ross, N. E., 1949. On a Cretaceous Pollen and Spore Bearing Clay of Scania, a Preliminary Report, p. 123-127, 5 new species descriptions.

Potonié, R., 1934. Zur Mikrobotanik des eocaenen Humodils des Geiseltals, p. 128-182, 55 new species descriptions.

Glossary, Formula of Spores and Pollen Symbols, p. 183-184.

1-2500 Kremp, G.O.W., H.T. Ames, and Hilde Grebe. CATALOG OF FOSSIL SPORES AND POLLEN. VOLUME 2. MESOZOIC AND TERTIARY SPORES AND POLLEN: 178 p., illus., University Park, Pennsylvania, Pennsylvania State University, College of Mineral Industries, Dept. of Geology, Palynological Laboratories, 1957, refs.

Vol. 2 of the catalog contains 171 additional specific descriptions, bringing the total to 353 original descriptions in the combined volumes. These additional Mesozoic and Tertiary types are from Europe and New Zealand. As in the earlier volume, the descriptions are accompanied by an alphabetized generic-specific index. It is planned that following the publication of every fourth or fifth volume a cumulative index will be prepared.

In an attempt to present the subscribers with some of the less readily available papers, this volume contains additional types described by Potonié's abbreviated formulae. Those wishing to translate these symbols are referred to the appendix of Vol. 1 entitled Glossary, Formula of Fossil Spores and Pollen Symbols. --From introd.

Contents:

Weyland and Krieger, 1953. Die Sporen und Pollen der Aachener Kreide und ihre Bedeutung für die Charakterisierung des Mittleren Senons, p. 1-44, 44 new species descriptions.

Weyland and Greifeld, 1953. Über struktúrbietende Blätter und pflanzliche Mikrofossilien aus den Untersenonen Tonen der Gegend von Quedlinburg, p. 45-62, 18 new species descriptions.

Potonié, R, 1931. Zur Mikroskopie der Braunkohlen. Tertiaere Blütenstaubformen, (1. Mitt.), p. 63-113, 51 new species descriptions.

Couper, R.A., 1953. Upper Mesozoic and Cainozoic Spores and Pollen Grains from New Zealand, p. 114-171, 58 new species descriptions.

1-2501. Kremp, G.O.W., H.T. Ames, and Hilde Grebe. CATALOG OF FOSSIL SPORES AND POLLEN. VOLUME 3. TERTIARY SPORES AND POLLEN: 187 p., illus., University Park, Pennsylvania, Pennsylvania State University, College of Mineral Industries, Dept. of Geology, Palynological Laboratories, 1958, refs.

Vol. 3 of the catalog contains the species described by Thomson and Pflug in their publication entitled "Pollen und Sporen des Mitteleuropäischen Tertiärs." In an effort to facilitate interpretation of the descriptions, the diagnoses of all taxa above specific rank are presented as a supplement to the volume. Without this supporting data the specific descriptions, when removed from context, appear very incomplete. Using the figures and symbols of the original authors, each species description includes a reference to the appropriate diagnosis in the supplement as a means of aiding the reader in the development of a complete description. This involves the use of a capital letter to distinguish between pollen and spores, a Roman numeral to identify the major morphographic category, and an Arabic numeral which serves to identify the generic description. These 3 are occasionally followed by a lower case letter used to designate a section of the genus (e. g. B-VI-2-a or BVI2a). --From introd.

Contents:

Thomson, P. W., and H. Pflug, 1953. Pollen und Sporen des Mitteleuropäischen Tertiärs, p. 1-170, 170 new species descriptions.

Supplementary Information for the Specific Descriptions of Thomson and Pflug, p. 171-180.

1-2502. Kremp, G.O.W., H.T. Ames, and A.J. Kovar. CATALOG OF FOSSIL SPORES AND POLLEN. VOLUME 4. CRETACEOUS AND TERTIARY SPORES AND POLLEN: 167 p., illus., University Park, Pennsylvania, Pennsylvania State University, College of Mineral Industries, Dept. of Geology, Palynological Laboratories, 1958, refs.

One hundred and sixty specific descriptions from geographically dispersed Cretaceous and Tertiary sediments are presented in Vol. 4. It includes new spore and pollen types reported from Asia, central and eastern Europe, New Zealand, and North America. These additional descriptions combined with those of the earlier volumes bring the total republished species to 683 during the initial year of catalog activity. --From introd.

Contents:

Couper, R. A., 1954. Plant Microfossils from New Zealand No. I., p. 1-7, 7 new species descriptions.

Delcourt and Sprumont, 1955. Les spores et grains de pollen du Wealdien du Hainaut, p. 8-35, 28 new species descriptions.

Wolff, H., 1934. Mikrofossilien des pliozänen

Humodils der Grube Freigericht bei Dettingen a. M. und Vergleich mit älteren Schichten des Tertiärs so wie posttertiären Ablagerungen, p. 36-49, 14 new species descriptions.

Zaklinskaya, E. D., 1957. Stratigraphic Significance of Pollen Grains of Gymnosperms of the Cenozoic Deposits of the Irtysh Basin and of the Northern Aral Basin, p. 50-93, 44 new species descriptions (in Russian).

Kremp, G., 1949. Pollenanalytische Untersuchung des miozänen Braunkohlenlagers von Konin an der Warthe, p. 94-96, 3 new species descriptions.

Potonié and Venitz, 1934. Zur Mikrobotanik des miozänen Humodils der niederrheinischen Bucht, p. 97-104, 8 new species descriptions.

Potonié, R., 1931. Zur Mikroskopie der Braunkohlen. Tertiäre Sporen- und Blütenstaubformen, (4 Mitt.), p. 105-119, 15 new species descriptions.

Rouse, G., 1957. The Application of a New Nomenclatural Approach to Upper Cretaceous Plant Microfossils from Western Canada, p. 120-140, 21 new species descriptions.

Potonié, R., 1931. Pollenformen der miocänen Braunkohle, (2 Mitt.), p. 141-150, 20 new species descriptions.

1-2503. Kremp, G.O.W., and H.T. Ames. CATALOG OF FOSSIL SPORES AND POLLEN. VOLUME 5. CARBONIFEROUS SPORES: 160 p., illus., University Park, Pennsylvania, Pennsylvania State University, College of Mineral Industries, Dept. of Geology, Palynological Laboratories, 1959, refs.

Vol. 5 is the first volume of the catalog to be devoted to the presentation of Paleozoic spores. It contains 153 original specific descriptions. Only spores and prepollen less than 250 microns in diameter appear in this volume. --From introd.

Contents:

Schopf, J., L. Wilson, and R. Bentall., 1944. An Annotated Synopsis of Paleozoic Spores and the Definition of Generic Groups, p. 1-4, 4 new species descriptions.

Kosanke, R., 1950. Pennsylvanian Spores of Illinois and Their Use in Correlation, p. 5-104, 100 new species descriptions.

Potonié, R., A. C. Ibrahim, and F. Loose., 1932. Sporenformen aus den Flözen Ägir und Bismarck des Ruhrgebietes, p. 105-151, 47 new species descriptions.

Wicher, C. A., 1934. Sporenformen der Flammkohle des Ruhrgebietes. Systematische Untersuchung eines Flözes der Flammkohlenpartie (Westfal C) auf seinen Sporeninhalt und kritscher Ausblich auf den Wert der Sporen für die Stratigraphie des Karbons, p. 152-153, 2 new species descriptions.

1-2504. Kremp, G.O.W., and H.T. Ames. CATALOG OF FOSSIL SPORES AND POLLEN. VOLUME 6. PENNSYLVANIAN SPORES: 166 p., illus., University Park, Pennsylvania, Pennsylvania State University, College of Mineral Industries, Dept. of Geology, Palynological Laboratories, 1959, refs.

Vol. 6 of the catalog contains 159 new or redescribed specific descriptions. Except for Potonié and Kremp Pts. I and II, only descriptions of new species are included. In the case of Potonié and Kremp's paper certain supplemental species descriptions are presented in order to provide photomicrographic illustrations of the holotypes. The original descriptions of these redescribed forms were published during the early 1930's in the abbreviated style commonly employed by German workers in this period. Subsequently, many of these species were designated as types of larger taxa. --From introd.

Contents:

Ibrahim, A. C., 1933. Sporenformen des Aegirhorizonts des Ruhr-Reviers, p. 1-31, 31 new species descriptions.

Loose, F., 1934. Sporenformen aus dem Flöz Bismarck des Ruhrgebietes, p. 32-52, 21 new species descriptions.

Kremp, G., 1952. Sporen-Vergesellschaftungen und Mikrofaunen-Horizonte im Ruhrkarbon, p. 53, 1 new species description.

Potonié, R., and G. Kremp, 1955. Die Sporae dispersae des Ruhrkarbons ihre Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte, Teil I, p. 54-123, 70 new species descriptions.

Potonié, R., and G. Kremp, 1956. Die Sporae dispersae des Ruhrkarbons ihre Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte, Teil II, p. 124-159, 36 new species descriptions.

1-2505. Kremp, G.O.W., H.T. Ames, and A.J. Kovar. CATALOG OF FOSSIL SPORES AND POLLEN. VOLUME 7. MISSISSIPPIAN AND PENNSYLVANIAN SPORES: 159 p., illus., University Park, Pennsylvania, Pennsylvania State University, College of Mineral Industries, Dept. of Geology, Palynological Laboratories, 1959, refs.

One hundred and fifty-two descriptions of Paleozoic species are presented in Vol. 7 of the catalog.

Contents:

Berry, W., 1937. Spores from the Pennington Coal, Rhea County, Tennessee, p. 1-14, 14 new species descriptions.

Wilson, L. R. and E. A. Coe, 1940. Descriptions of Some Unassigned Plant Microfossils from the Des Moines Series of Iowa, p. 15-25, 11 new species descriptions.

Schemel, M. P., 1951. Small Spores of the Mystic Coal of Iowa, p. 26-28, 3 new species descriptions.

Potonié, R. and G. Kremp, 1954. Die Gattungen der paläozoischen Sporae dispersae und ihre Stratigraphie, p. 29-32, 4 new species descriptions.

Ishchenko, A. M., 1956. Spores and Pollen of the Lower Carboniferous Deposits of the Western Extension of the Donets Basin and Their Stratigraphic Importance, p. 33-152, 120 new species descriptions (in Russian).

1-2506. Kremp, G.O.W., H.T. Ames, and A.J. Kovar. CATALOG OF FOSSIL SPORES AND POLLEN. VOLUME 8. CRETACEOUS SPORES AND POLLEN: 163 p., illus., University Park, Pennsylvania, Pennsylvania State University, College of Mineral Industries, Dept. of Geology, Palynological Laboratories, 1959, refs.

One hundred and fifty-five specific descriptions of Mesozoic types are presented in Vol. 8.

Contents:

Bolkhovitina, N. A., 1953. Spores and Pollen Characteristic of Cretaceous Deposits of Central Regions of the U. S. S. R., p. 1-152, 152 new species descriptions (in Russian).

Miner, E. L., 1935. Paleobotanical Examinations of Cretaceous and Tertiary Coals, p. 153-155, 3 new species descriptions.

1-2507. Stanley, E.A., and G.O.W. Kremp. SOME OBSERVATIONS ON THE GENICULUS IN THE POLLEN OF QUERCUS PRINOIDES: Micropaleontology, v. 5, no. 3, p. 351-354, illus., pl., July 1959, 2 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. 58-121.

The term "geniculus" was introduced by R. Potonié (1934) for "a small peculiarity as an inwardly or outwardly turned equatorial knee in pollen grains." An attempt is made here to determine the exact nature of this "small peculiarity" in pollen of Quercus prinoides by using a new technique which permits reconstruction of the pollen grain from serial photographs taken at every half micron through it. The geniculus is found to be an equatorial thinning and bulging of the exine, which is thought to serve as an aid in germination. It is present in several species of the genus Quercus and appears to be characteristic of the genus. The geniculus is also found to occur in species of several genera that are assigned to families other than the Fagaceae. --Auth.

1-2508. Felix, Charles J., and Patricia Parks. AN AMERICAN OCCURRENCE OF SPENCERISPORITES: Micropaleontology, v. 5, no. 3, p. 359-364, 8 illus. on 2 pls., July 1959, 14 refs.

The Paleozoic lycopodiaceous spore genus Spencerisporites is recorded from an American locality. The taxonomy of Spencerisporites radiatus (Ibrahim) Chaloner is discussed and its synonymy listed. A description is presented of representatives of the species from the upper Morrow [Pennsylvanian] of the Texas-Oklahoma Panhandle. --Auth.

1-2509. Hoffmeister, William S. LOWER SILURIAN PLANT SPORES FROM LIBYA: Micropaleontology, v. 5, no. 3, p. 331-334, diag., pl., July 1959, 7 refs.

Two genera, one of which is proposed as new, and 2 new species of plant spores found in a core from Esso Standard's (Libya), Inc. well Atshan No. 1-1, state of Fezzan, Libya, are described. Graptolites dated as "high" Lower Silurian are encountered in the material containing the spores. --Auth.

1-2510. Fry, Wayne L., and D.J. McLaren. FUNGAL FILAMENTS IN A DEVONIAN LIMESTONE FROM ALBERTA: Canada, Geol. Survey, Bull. 48 (Contributions to Canadian Palaeontology), p. 1-9, pls. 1-3, 1959, 5 refs.

Some peculiar filaments found in specimens of Devonian limestone about 29 mi. WSW. of Nordegg, are described. Fungal origin of the filaments is established, and evidence favoring a Devonian age is compared with evidence for a modern age. --P. Harker.

1-2511. Rouse, Glenn E. PLANT MICROFOSSILS FROM KOOTENAY COAL-MEASURES STRATA OF BRITISH COLUMBIA: Micropaleontology, v. 5, no. 3, p. 303-324, 2 pls., July 1959, 63 refs.

Plant microfossils from roof shale and shale-parting strata of the Kootenay coal-bearing formation of southeastern British Columbia are described and illustrated. The microfossils are affiliated as follows: 2 fungi, 1 bryophyte, 3 lycopsids, 12 ferns, 11 gymnosperms, 2 angiosperms, and 14 with uncertain botanical relationships. Techniques of maceration, mounting, and photomicrography are discussed. The microflora is related to the macroflora from the same formation, and compared briefly with similar microfloras from Europe and the U. S. S. R. The comparison suggests a closer age relationship to the Upper Jurassic than to the Lower Cretaceous. --Auth.

1-2512. Fry, Wayne L. PETRIFIED LOGS OF CUPRESSINOXYLON FROM THE WEST SHORE OF CHILKO LAKE, BRITISH COLUMBIA: Canada, Geol. Survey, Bull. 48 (Contributions to Canadian Palaeontology), p. 10-14, pls. 4-6, map, table, 1959, 7 refs.

An account of an occurrence of petrified logs is given. The wood is described and identified as a late Mesozoic and Teritary genus. The sediments containing the wood had been dated as Triassic, but this is shown to be most unlikely, and a later age is suggested. --P. Harker.

1-2513. Canright, James E. FOSSIL PLANTS OF INDIANA: Indiana, Geol. Survey, Rept. Prog. 14, 45 p., 3 figs., 5 pls., 3 tables, 1959.

Plant fossils were first recorded in Indiana by David Dale Owen in 1843. Lesquereux's Description of the Coal Flora of the Carboniferous Formation in Pennsylvania and Throughout the United States, published in 1880, listed 54 fossil plants from Indiana, and David White in 1896 identified 19 specimens from the whetstone beds of Orange County. Very little paleobotanical work has been done since then.

Stems, leaves, and cones of lycopsids and sphenopsids are common in the rocks associated with the coal beds of southwestern Indiana, and the seed ferns and Cordaitales are also found there. Fernlike foliage is abundant in the shales, and therefore a key to identify the common genera of fernlike leaves has been prepared for the lay reader.

The fossil plants found in southwestern Indiana at 93 collecting sites comprise 146 species assignable to 68 genera. --Auth.

6. GEOPHYSICS

See also: Geomorphology 1-2458; Geohydrology 1-2578; Fuels 1-2629, 1-2648.

1-2514. Hinze, William J. A GRAVITY INVESTIGATION OF THE BARABOO SYNCLINE REGION: Jour. Geology, v. 67, no. 4, p. 417-446, 11 maps (3 fold.), 11 gravity profiles, 2 tables, July 1959, 38 refs.

A gravity investigation is presented of the Baraboo syncline, which is an inlier of folded Precambrian igneous and metasedimentary rocks in the flat-lying Paleozoic sedimentary rocks of S.-central Wisconsin. This investigation shows that gravity measurements can be useful in depicting the surface geology (lithology and structure) of a limited structural feature - the Baraboo syncline. The regional gravity anomaly consists of the southern terminus of a gravity minimum that is centered over Wisconsin. This minimum is interpreted in the light of seismic crustal studies as originating from a thickening of both the "granitic" layer and the earth's crust.

A distinct gravity minimum which cannot be explained by surface geology is found associated with the Baraboo syncline. It is interpreted as originating from a local increase in thickness of the "granitic" layer. This minimum, which is quantiatively investigated, provides the clue which suggests that the Baraboo syncline does not terminate at its western end, as generally believed, but rather extends to the SW. for an additional 5 mi. Other structural and lithologic relations of the syncline are studied with the aid of the gravity data. An analysis of the complementary magnetic study of the Baraboo syncline substantiates the conclusions reached from the gravity investigation. --Auth.

1-2515. Rochester, Michael G. GEOMAGNETIC WESTWARD DRIFT AND IRREGULARITIES IN THE EARTH'S ROTATION. FINAL REPORT: California, Univ., Scripps Inst. Oceanography, Contract Nonr 2216(03), 53 p., 2 figs., table, La Jolla, California, 1959.

Bullard's (1950) rigid-sphere model for the steady westward drift of the earth's nondipole magnetic field is extended to include the magnetic coupling provided by the presence of the higher multipole fields at the core-mantle boundary. If the first 6 harmonics of the observed surface field are taken into account, the retarding couple on the mantle is increased by a factor of 1.6. Using this result it would follow from Bullard's specialized model of the core that the geomagnetic dynamo mechanism generates a toroidal field of several hundred gauss in the deep interior of the core. Time-dependent perturbations of the mantle-core coupling are investigated rigorously, and it is shown that reasonable fluctuations of the fields at the core-mantle boundary are capable of explaining changes in the length of day at the rate of order 1 millisecond in 10 yrs. The tightness of the coupling is increased by 60% over that afforded by Bullard's model. The argument provides additional evidence that the mean electrical conductivity in the bottom 2,000 km. of the mantle is at least 10^{-9} e.m.u. A summary of knowledge of the distribution of electrical conductivity with depth in the earth is given in the introduction. --Auth.

1-2516. Johnson, Robert B. RESISTIVITY SURVEY-A GOOD BET IN PRELIMINARY SEARCHES FOR DEPOSITS: Rock Products, v. 62, no. 3, p. 82-85, 4 figs., 1959.

Describes a quick economical method of finding and mapping deposits of sand, gravel, and limestone from the surface before test boring. Equipment, procedures, and some of the interpretation problems are discussed. --D. J. Barbour (courtesy Ceramic Abs., Aug. 1959, p. 218).

1-2517. Gross, Gerardo W., and E. James Moore. SPONTANEOUS POLARIZATION POTENTIALS AND CLAY AND LIMONITE DEPOSITS IN THE GATESBURG FORMATION OF CENTRAL PENNSYLVANIA: Econ. Geology, v. 54, no. 6, p. 1056-1067, map, 6 profiles, diag., Sept.-Oct. 1959, 20 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. no. 58-41.

Geophysical investigation of clay and limonite deposits related to the lower Paleozoic of central Pennsylvania shows the existence of broad belts of self-potential minima above the outcrops of the Cambrian Gatesburg formation. These S.P. minima are relate to the peculiar sandy residual soil covering the Gatesburg. A working hypothesis in terms of shale and liquid junction potentials is advanced to account for the phenomena. This appears to be confirmed by the "mirror image" relationship of S.P. profiles with resistivity profiles. The method may be useful in prospecting for clay deposits and in locating certain geological boundaries. --Auth.

1-2518. Hodgson, John H., ed. THE MECHANICS OF FAULTING WITH SPECIAL REFERENCE TO THE FAULT-PLANE WORK (A SYMPOSIUM): Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 251-418, maps, diags., graphs, tables, 1959, refs.

Most of the papers in this symposium were presented at the Eleventh General Assembly of the Internation Union of Geodesy and Geophysics, held at Toronto, Canada, in 1957.

During the past few years the study of the mechanism of earthquakes has occupied the attention of 4 major "schools" of seismology, one in Japan, one in Holland, one in the Soviet Union and one, of broad geographical distribution, made up of the followers of Byerly. The present volume contains contributions from each of these groups, as papers interpreting the fault-plane results in terms of tectonophysics.

The 12 papers are presented in logical order: thos dealing with theory of the fundamentals of method, then those giving the summary of the results obtained by the various working groups, and finally, papers dealing with the interpretation of results. --From ed. foreword and P. L. Willmore.

Each paper is separately abstracted below in the order in which it appears in the symposium.

1-2519. Byerly, Perry, and Willian V. Stauder. MOTION AT THE SOURCE OF AN EARTHQUAKE (In: Hodgson, John H., ed. The Mechanics of Faultin . . . a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 255-261, 5 diags., 1959) 8 refs.

Nakano's theoretical development emphasizes the effect of seismic disturbances at large distances from the source and develops equations of first motio in P and S for several types of source mechanisms. These equations are compared to the methods of approach of various investigators, and 2 mechanisms in particular are singled out: a single couple, which represents motion along a fault, and a double couple, which represents a compressive and tensile stress at right angles. Methods of transformation and projection permit the application of the theory for an infinite homogeneous earth to the heterogeneous earth. Possible uses of S phases are noted. Single observations of the first motion of S offer the possibility of resolving the ambiguity in fault-plane solutions from P alone in which the single couple is the mechanism assumed. Identification of the second nodal surfaces of SV and SH offers a criterion for deciding which mechanism, the single couple or the double couple, is operative in particular earthquakes. Further, simple relations involving the ratios SH/SV, P/SH, P/SV suggest other approaches to the problem of motion at the source of an earthquake. S phases, however, are to be used with great care. --Auth.

1-2520. Ingram, R.E. STATISTICS AND THE FAULT PLANE, A CONJECTURE (In: Hodgson, John H., ed. The Mechanics of Faulting... a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 263-265, diag., 1959) 2 refs.

The paper is a note pointing to the possibility that statistics may be used to give the best position of the boundaries separating compressions from dilatations in fault-plane solutions. Tentative solutions are given for 2 simple cases, where separation is in terms of a single straight line, and where it is in terms of 2 straight lines. In each case a discriminating function is used to determine the best equation for the lines. --Auth.

1-2521. Dix, C. Hewitt. MECHANISMS OF FAULTING (In: Hodgson, John H., ed. The Mechanics of Faulting... a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 267-270, 2 diags., 1959) 13 refs.

The faulting picture shown by E. M. Anderson in his book using C. E. Inglis' stress calculations is examined, and it appears difficult to extract energy for radiation in seismic waves from such a picture. Before and after the formation of such a crack the stress energy appears to be approximately the same.

However, if there are 2 pre-existing "lubricated" approximately co-planar sheet regions or sheet regions weaker than their surrounding rocks with a strong solid region between them, then this solid between may be ruptured and energy radiated. This may be modified to include the growth of a simple single lubricated crack, but this later process does not seem adequate for large earthquakes. --Auth.

1-2522. Press, Frank. ELASTIC WAVE RADIATION FROM FAULTS IN ULTRASONIC MODELS (In: Hodgson, John H., ed. The Mechanics of Faulting... a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 271-277, 8 diags., 2 graphs, 1959) 6 refs.

An ultrasonic model of an impulsive fault is used to study the radiation pattern of compressional and shear waves. Azimuthal variations of direction of initial motion of compressional and shear waves are described. The behavior of the compressional waves follows the classical theory for radiation from a dipole source. The behavior of the shear waves is anomalous in that significant motion occurs whereas nodes are expected. The relation of this work to current practices in obtaining fault-plane solution is discussed. --Auth.

1-2523. Keylis-Borok, V.I. THE STUDY OF EARTHQUAKE MECHANISM (In: Hodgson, John H., ed. The Mechanics of Faulting... a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 279-294, 14 figs. incl. maps, diags., 1959) 19 refs.

The determination of dynamic parameters of earthquake foci (the mechanical character of rupture at the focus, the fault-plane orientation, the direction of movement) is made by the method described in the 1954 Assembly publications. It is, in principle, similar to the method of Byerly and of the Japanese seismologists, as described by Byerly in the present symposium. The main feature of the method is the use of S waves, which makes the results single-valued and drastically reduces the number of observations necessary, as well as the ratios of displacement amplitudes in different waves.

The following are the main improvements in method achieved within recent years:

a) Simple methods have been worked out to exclude the influence of discontinuities on the shape of the observed waves.

b) A graphical method, making use of the Wulff stereographic projection, has been developed, which makes it possible to determine the direction of the "straightened rays" when there are refracting boundaries of any number and shape.

c) Additional theoretical grounds are given for the commonly used substitution of a multipole for the focus. While almost all earthquakes which we have studied appear to be due to a dipole with moment, several more complicated models have been investigated.

Determination has been made of the mechanisms of 300 earthquakes in the main seismically active zones of the U. S. S. R. and adjoining regions: the western Pacific (from the Marianas Islands to the Aleutian Islands), the Hindu-Kush, the Pamirs and Tien-Shan, Kopet-Dag and western Turkmenia, and the Caucasus. Of special interest is the Garm region (on the border of the Pamirs and Tien-Shan) where about 150 weak earthquakes, occurring within a small area, were studied.

The basic properties of dislocations in the foci of each zone have been found and compared with the general tectonics.

a) In some regions one strike direction predominates; in some instances this is parallel, in other instances transverse, to the strike of the main structures. In most regions, however, both systems are developed at the same time.

b) Faults with strong horizontal components of movement and with strikes transverse to the structures are much more common in the seismic solutions than they are from geological data. However, this is in line with some neotectonic data.

c) Vertical movements in the foci of some regions are characterized by the fact that during earthquakes a fault wall facing a tectonic depression is lifted up in the earthquake. This is in agreement with geological and geophysical evidence on the movements of surface foci in Japan. Vertical movements during earthquakes are in the opposite sense to the secular ones.

The data obtained are of interest in deep tectonics, its relation with seismicity, etc. A great number of foci should be investigated in different tectonic regions. In this connection, international exchange of information and data is of paramount importance; this interchange is now very well established. --Auth.

1-2524. Honda, Hirokichi. THE MECHANISM OF THE EARTHQUAKES (In: Hodgson, John H., ed. The Mechanics of Faulting... a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 295-340, 60 figs. incl. maps, diags., graphs, 2 tables, 1959) 122 refs.; reprinted from Tohôku Univ., Japan, Science Repts., Ser. 5, Geophysics, v. 9, supp.

A brief account of development of knowledge on the mechanism of earthquakes since about the year 1930 is given in this report.

There are 2 kinds of prevailing hypotheses as to earthquake mechanism. In one, a couple of 2 equal and opposite forces with moment is supposed to act at the focus of the earthquake, while in the other, a set of 2 couples of forces with moment which are perpendicular to each other is assumed. We will call the former the force system of type I, and the latter that of type II. A set of 2 couples of forces of the nature of pressure and tension which are perpendicular to each other, and the radial force proportional to $\sin 2\theta \cos \phi$ in spherical coordinates, are equivalent to the force system of type II.

The distribution of direction and magnitude of initial motion of the P, S, and ScS waves of near deep and intermediate earthquakes observed in Japan can be explained by theories based on the assumption that the force system of type II acts at the origin in an infinite elastic solid. The directions of pressure of the stresses causing the earthquakes seem to be directed perpendicularly to the trends of the deep and intermediate earthquake zones in and near Japan. For the investigation of P, S, and surface waves and deformation of the earth's surface observed in very shallow earthquakes in Japan, the theories for the force system of the nature of type II or the radial force proportional to $\sin 2\phi$ in cylindrical coordinates, acting at the origin on the surface of a semi-infinite elastic solid, have been applied.

The stereographic projection methods which are appropriate for investigation of the earthquake mechanism, based on observations at stations distributed over the world, have been proposed and developed by P. Byerly and J. H. Hodgson, and applied to studies of numerous earthquakes by many seismologists, the force system of type I being assumed as the basis of the investigation. The place bisecting the couple of forces is considered to be the fault plane. The relations between strikes and dips of the fault planes, motion directions along the fault planes, and geological features, are investigated.

According to the theories on elastic waves, the patterns of the initial motions of P waves for the force systems of types I and II are similar. As the differences of the effects of the force systems are to be noticed in the patterns of the S waves, it is desired that the S waves observed at distant stations may be investigated further. --Auth.

1-2525. Ritsema, A.R. ON THE FOCAL MECHANISM OF SOUTHEAST ASIAN EARTHQUAKES (In: Hodgson, John H., ed. The Mechanics of Faulting... a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 341-368, 20 figs. incl. maps, diags., graph, 8 tables, 1959) 22 refs.

The mechanism in the focus of about 60 SE. Asian earthquakes has been determined. Byerly's method in the form developed by the present writer is used. With the help of seismogram readings of the position of the line of polarization of S waves, it was determined that in at least 12 of the shocks a single couple of forces acting along the line of fault movement was the cause of the earthquakes. In about half of the total material, however, no conclusive evidence could be found for a choice between this type of mechanism in the focus and that of 2 opposite couples of forces of equal magnitude acting along lines perpendicular to each other. In the following it is assumed that these shocks also are caused by the first-mentioned force system in the focus. Following and amplifying Hodgson's statement, it is concluded that sufficiently reliable data for earthquake mechanism studies can be expected only from P, PKP, and S waves. According to the fault movements in the focus, different earthquake types are distinguished (transcurrent, clockwise and counterclockwise, normal and reversed).

In the section dealing with SE. Asian earthquake mechanism, it is seen that transcurrent fault movements are about 3 times more common than they should be in case of a chance distribution of earthquake types. Evidence is given for small differences of earthquake mechanisms in depth and region. It is concluded that most of the fault displacements are directed perpendicular to the steeply dipping zones of seismic activity in the region. In the shocks in which these directions do not coincide, the plane of action still stands more or less perpendicular to this zone. This coincidence for the great majority of the earthquakes can only mean that the distribution of earthquakes in space and the fault displacements of the same probably are expressions of one and the same causal fact.

From the earthquake mechanisms shown to exist in the New Guinea-Solomons arcs it should follow that in these areas the seismic activity is concentrated in a zone steeply dipping under the Pacific Ocean side and not under the continental (i. e. Australian) side as is the case in the Sunda and the Celebes-Philippines arcs. --Auth.

1-2526. Hodgson, John H. THE NULL VECTOR AS A GUIDE TO REGIONAL TECTONIC PATTERNS (In: Hodgson, John H., ed. The Mechanics of Faulting... a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 369-384, 10 figs. incl. maps, diags., 2 tables, 1959) 24 refs.

The paper is a sequel to one published earlier (Hodgson, 1957) in which 75 solutions were summarized and discussed. Here 86 additional solutions are given, from various authors, making a total of 161 solutions available for discussion.

Two new areas, SE. Asia and the zone from the Marianas to Japan, have been added to the 2 already known in which faulting is not exclusively strike-slip. While there can be no doubt of the extreme importance of strike-slip faulting, it appears possible that a disproportionate number of solutions have come from areas in which faulting is exclusively strike-slip, and that the importance of strike-slip faulting has thereby been overemphasized in earlier papers.

Analysis of the direction of dip-slip gives no support to the contraction hypothesis, either in limited areas or in the world as a whole.

The null vectors for tectonically simple areas show simple patterns related to the geographic features. This inspires some confidence in the null vector as a diagnostic tool. So used, it suggests that in both the NE. Pacific and the NW. Pacific a double system of failures is going on, while the Aleutians, central Asia, and the Mediterranean are so tectonically complex that only limited areas can be considered at the same time. --Auth.

1-2527. McIntyre, Donald B., and John M. Christie. THE KINEMATICS OF FAULTING FROM SEISMIC DATA (In: Hodgson, John H., ed. The Mechanics of Faulting...a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 385-393, 7 diags., 1959) 8 refs.

The attitude of a fault and the nature of the slip on it can be determined from the pattern of distribution over the globe of compressional and dilatational first motions of P waves. The method as used by Byerly and Hodgson gives 2 possible solutions for each earthquake. The writers have already demonstrated that in an area showing a certain type of structural homogeneity, the ambiguity might be resolved by consideration of the geometrical relations between the pairs of solutions. It was concluded that in the SW. Pacific the movement was on steep strike-slip faults striking parallel to the physiographic feature. In the present paper, solutions from other areas are discussed.

On the assumption that the ambiguity of the results of a P-wave analysis can be resolved by study of the first motions of S waves, Kogan has derived unique solutions for the NW. Pacific. It is shown that Kogan's results for the Japan-Kamchatka area differ markedly from Hodgson's solutions for the same region and time interval based on P-wave records obtained at stations distributed all over the world. Similarly the solutions of Honda et al for the same area and time interval differ markedly from the solutions of both Hodgson and Kogan.

The value of solutions for an earthquake sequence is emphasized, and an analysis of a series of Greek earthquakes is attempted. --Auth.

1-2528. Benioff, Hugo. CIRCUM-PACIFIC TECTONICS (In: Hodgson, John H., ed. The Mechanics of Faulting...a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 395-402, 5 maps, diag., 1959) 14 refs.

A study of the Kamchatka aftershock sequence by Båth and Benioff provided the basis for distinguishing between the 2 possible fault-plane solutions for the principal shock given by Hodgson. Thus, this great earthquake was generated by a right-handed slip on a 1,000-km. fault segment lying parallel to the trench. With this observation, data are now available for the direction of slip on the shallow components of nearly all the principal circum-Pacific faults. This includes Japan, Philippines, Tonga-Kermadec, New Zealand, the Aleutian Arc, Alaska, NW. Pacific, California, and possibly the western coast of South America. In all of these regions the principal fault lies parallel to the coast and the slip is right-handed. Secondary faulting, such as represented by the Garlock fault in California, strikes transverse to the coast line and in many cases is left-handed. Although the principal movement is strike-slip in nature, smaller dip-slip components also occur, and these are responsible for the relief which takes the form of oceanic deeps and associated mountain ranges. The circum-Pacific tectonic activity now in progress can thus be described as a tangential, clockwise rotation of the continental margins relative to the oceanic mass, together with a radial movement of the margins toward the oceanic mass. If the tangential slip is constant around the margins, with a rate equal to that of the San Andreas, the time for a complete revolution is approximately 3×10^9 years. --Auth.

1-2529. St. Amand, Pierre. CIRCUM-PACIFIC OROGENY (In: Hodgson, John H., ed. The Mechanics of Faulting...a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 403-411, 4 maps, 1959) 12 refs.

The Pacific coast of North America is fringed by a series of right lateral faults subparallel to the coastline. The San Andreas fault extends from Baja California to a point off the Oregon-Washington coast. Near this point, the Alaskan fault complex begins and continues past the Queen Charlotte Islands, along the coast and inland to join the Denali fault. This zone of faulting extends for more than 2,100 km. from Lynn Canal, by the N. face of Mt. McKinley, to the Bering Sea. Faulting on the Alaska peninsula having the trend of the Aleutian Island arc has been mapped as right lateral faulting with concomitant overthrusting. First motion results from seismology indicate that movement along the Aleutian arc, the Kamchatka-Kurile arc, and elsewhere around the Pacific may be aligned parallel to the strike of the island arcs or mountain chains, and is often of right lateral sense. The conclusion is presented that the Pacific basin from at least Baja California to a point beyond the Kurile Islands is rotating counterclockwise. The rest of the Pacific basin is probably also rotating in the same sense. The Rocky Mountain trench and subparallel features between it and the coast indicate that this type of movement has been going on a very long time and represents a fundamental type of orogeny. The results of field and structural geology at this stage of our knowledge support the basic work of Byerly and of Hodgson and aid in defining the nature of circum-Pacific orogeny. --Auth.

1-2530. Hodgson, John H. CURRENT STATUS OF FAULT-PLANE STUDIES - A SUMMING UP (In: Hodgson, John H., ed. The Mechanics of Faulting...a Symposium: Canada, Dominion Observatory, Pub., v. 20, no. 2, p. 413-418, 1959) 8 refs.

The paper attempts to state the present position of the fault-plane work, as defined by the contributions to this symposium. The conclusions are:

1) There is a fundamental disagreement about mechanism which must be solved before the results may be interpreted unambiguously. The disagreement involves the interpretation of S.

2) Assuming a fault mechanism, faulting is predominantly strike-slip except in limited areas. Where unambiguous solutions have been obtained they usually suggest displacement perpendicular to the feature.

3) Assuming the alternative force mechanism, the principal forces appear to act normal to the geographic feature in most areas.

4) The most pressing need of the fault-plane work is agreement on the interpretation of S. This should be sought through studies in theoretical and model seismology and by the careful examination of many seismograms. --Auth.

1-2531. Kaarsberg, E.A. INTRODUCTORY STUDIES OF NATURAL AND ARTIFICIAL ARGILLACEOUS AGGREGATES BY SOUND-PROPAGATION AND X-RAY DIFFRACTION METHODS: Jour. Geology, v. 67, no. 4, p. 447-472, 2 maps, 2 diags., 15 graphs, 6 tables, July 1959, 24 refs.

Field evidence has shown wide variation in the velocities of sound waves in shales, the most abundant sedimentary-rock type. The sound velocity in and the bulk densities of a variety of natural and artificial aggregates were measured, and an attempt was made to show how mineral composition, particle orientation, and interparticle adhesion affect the velocity-density relationship. In natural samples minerals were identified by X-ray diffraction, and the degree of preferred orientation of the illite particles was measured by comparing the ratio of the intensities of the (002) to (110) lines obtained from irradiated sections cut parallel and perpendicular to the bedding.

Sound-velocity measurements and X-ray results indicate that the bedding planes of flat-lying argillaceous sediments have circular symmetry for all stages of compaction and that the degree of preferred orientation parallel to the bedding plane of the basal planes of illite particles increases with increasing compaction. Large differences in sound velocities in similarly prepared drying illite and kaolinite aggregates are explained on the basis of their different fine-structure bonding. A tentative explanation is offered for the observed variation in sound velocity in pure and mixed aggregates with water content.

The sound velocity in kaolinite-quartz sand mixtures apparently cannot be explained by any simple averaging of component properties but is probably intimately related to the differences in the adhesion between kaolinite particles themselves and kaolinite and sand particles. Other tentative conclusions are advanced which will require study of larger varieties of both natural and artificial aggregates for confirmation. --Auth.

1-2532. Arnold, James R., and E.A. Martell. THE CIRCULATION OF RADIOACTIVE ISOTOPES: Sci. American, v. 201, no. 3, p. 84-93, 8 illus., 2 graphs, Sept. 1959.

Experiments with nuclear explosions have stimulated man to study the distribution of radioisotopes in his environment. These investigations have clarified many geophysical processes, including the absolute dating of the age of rocks and archeological finds, and the circulation of the atmosphere and oceans. Radioactive isotopes created and released by nuclear explosions may be a potential health hazard, but they have also provided the means for making extremely detailed studies on meteorlogical conditions. --M. Russell.

1-2533. Whitaker, W.W., S. Valastro, Jr., and Milton Williams. THE CLIMATIC FACTOR IN THE RADIOCARBON CONTENT OF WOODS: Jour. Geophys. Research, v. 64, no. 8, p. 1023-1029, 6 graphs, 2 tables, Aug. 1959, 8 refs.

Past research has shown significant variations in radiocarbon contents of woods from different environments and in the degrees to which these radiocarbon contents reflect dilution of atmospheric carbon dioxide by carbon dioxide from fossil fuels. The present work attempts to relate these variations to climatic factors. Comparison of radiocarbon contents of individual tree rings with thicknesses of the rings and, in some cases, with meteorological records suggests that the radiocarbon contents of rings produced in years of heavy rainfall may be relatively low and that the contents of rings added in times of drought may be comparatively high. The year-to-year fluctuations in radiocarbon content observed in individual trees probably cannot be ascribed to rainfall alone, but likely also depend upon other factors. The apparent dependence of radiocarbon content on climate seems to be a result of a varying contribution to the tree of C from the pedosphere. --Auth.

1-2534. Brownell, George M. A BERYLLIUM DETECTOR FOR FIELD EXPLORATION: Econ. Geology, v. 54, no. 6, p. 1103-1114, 2 illus., diag., 3 graphs, Sept.-Oct. 1959, 10 refs.

The portable instrument, here referred to as a "berylometer," is a new geophysical tool for the use of the geologists in both exploration and examination of Be deposits. This is a scintillation counter which contains a phosphor having a high neutron to gamma ratio of detection and makes use of the $Be^9 (\gamma, n) Be^8$ reaction. A gamma emitting source is carried in a shield on the bottom of the instrument which, when set upon any Be-bearing mineral or rock, causes the emission of neutrons from the Be which are immediately recognizable. Gamma rays are biased out, and neutrons only are counted. An automatic counting register records the neutron count, and since this is directly proportional to the Be content of a sample, a simple means of analysis is provided.

The use of Be would expand rapidly if adequate reserves could be established and also if, with increased production, a lower cost could be attained. The discovery of nonpegmatitic deposits offers a better prospect for the development of substantial reserves in contrast to the generally small size of Be-bearing zones as found in pegmatites. Towards this end the berylometer provides a much-needed field instrument for all persons engaged in the search for Be ore. --Auth.

1-2535. Benseman, R.F. SUBSURFACE DISCHARGE FROM THERMAL SPRINGS: Jour. Geophys. Research, v. 64, no. 8, p. 1063-1065, graph, table, Aug. 1959.

Individual hot springs in thermal regions have only a fractional discharge at the surface because a large proportion of the water leaves by underground paths. A new and more realistic concept of the activity of a spring is the "turnover rate" (R), which allows the water throughput to be defined without reference to the surface discharge. A method for determining R is described. --Auth.

1-2536. Benseman, R.F. ESTIMATING THE TOTAL HEAT OUTPUT OF NATURAL THERMAL REGIONS: Jour. Geophys. Research, v. 64, no. 8, p. 1057-1062, map, graph, 3 tables, Aug. 1959, 6 refs.

The natural flow of heat from a thermal region is a first indication of the amount of steam that might be continually drawn from bores to generate electric power. Methods are described for assessing the natural heat flow by such agencies as steaming ground, geysers, springs, fumaroles, and the underground seepage of hot water to nearby streams or lakes. --Auth.

Examples are given from New Zealand.

7. GEOCHEMISTRY

See also: Mineralogy 1-2556; Geohydrology 1-2577, 1-2578.

1-2537. Horr, C. Albert. A SURVEY OF ANALYTICAL METHODS FOR THE DETERMINATION OF STRONTIUM IN NATURAL WATER: U.S. Geol. Survey, Water-Supply Paper 1496-A, 18 p., June 1959, 83 refs.

Sr, an alkaline earth metal, is one of the more abundant trace elements in the lithosphere and is universally associated with Ca in igneous, sedimentary, and metamorphic rocks. During the weathering cycle, Sr is brought into solution and is transported principally as the bicarbonate.

The biological cycle of Sr parallels that of Ca. Natural Sr is not toxic to human life, but the artificially produced radioactive isotopes, especially Sr-89 and Sr-90, are highly toxic.

Chemical methods for determining Sr require separation of the element from other alkaline earth elements. The most reliable method for separating Ca from Sr is extraction with fuming nitric acid. Many methods have been reported in which organic solvents are used to extract anhydrous calcium nitrate from mixtures of calcium and strontium nitrate. Separations based on homogeneous precipitation or precipitate exchange and complex formation are also reported. In all these methods, reliable results can be attained only when corrections are applied to compensate for incomplete separations. Sr is usually determined gravimetrically, or volumetrically by oxidimetric titration of equivalent oxalate. Other volumetric methods are rarely used.

Emission spectrochemical methods have been applied to water analysis. These methods have the advantage that preliminary separations or other treatment of the water sample are usually unnecessary. Instrumentation and operational techniques for spectrographic analysis are well standardized. Among methods of introducing the sample into the excitation source are direct atomization, use of rotating-disk or porous-cup electrodes, evaporation of the sample on the electrodes, and packing a cupped electrode with the evaporation residue. The lower limit of detection is reported to be approximately 0.001 p.p.m.

Flame photometry is used extensively in analysis of solutions. Low-energy excitation produces simple spectra relatively free of interferences - an advantage in the analysis of complex solutions. Differences among methods are mainly in the choice of fuel and spectral line. The effects of some cations and anions on the emission of Sr have been studied. Sr may be detected in amounts as small as 0.2 p.p.m.

There are no satisfactory direct colorimetric methods for Sr. Indirect colorimetric methods are generally unsatisfactory and nonspecific. X-ray spectroscopy may be applied to evaporated water residues.

Column and paper chromatographic methods are convenient for concentrating and separating small amounts of Sr in water supplies. Adsorption and elution techniques for both column and paper chromatographic methods have been described by several authors.

Sensitive radiochemical methods of analysis for the radioactive isotopes of Sr, particularly Sr-90, have been developed. --Auth.

1-2538. McKinstry, Hugh E. MINERAL ASSEMBLAGES IN SULFIDE ORES: THE SYSTEM Cu-Fe-S-O: Econ. Geology, v. 54, no. 6, p. 975-1001, 7 diags., Sept.-Oct. 1959, 93 refs.

The paper presents the evidence supporting ternary phase diagrams proposed in earlier articles and builds a quaternary diagram making use of observed mineral associations to supplement available chemical data.

Phase relations explain the rarity or absence of a number of associations such as magnetite-covellite, pyrrhotite-hematite and, in the presence of magnetite, bornite-pyrite.

Although most commonly observed assemblages are apparently stable over a wide range of temperature there is a strong suggestion of shifting of tie-lines with change of temperature within the field of composition bounded by chalcocite, covellite, chalcopyrite, and pyrite.

The observed sequence in ore deposition is not so much a sequence of individual minerals as a sequence of assemblages, each higher than the preceding one in ratio of S to O and usually of Cu to Fe. However, it seldom reaches the ultimate high-S assemblage, covellite-pyrite. Late stage reversals of the trend (e.g., chalcocite replacing covellite) could be occasioned by waning of S supply before cooling was far advanced. Certain minerals such as pyrrhotite and magnetite are early members of the sequence, not because they are in themselves "high temperature" minerals, but because they are stable in low-S high-Fe assemblages. --Auth.

1-2539. Phillips, Bert and Arnulf Muan. PHASE EQUILIBRIA IN THE SYSTEM CaO-IRON OXIDE-SiO_2 IN AIR: Am. Ceramic Soc., Jour., v. 42, no. 9, p. 413-423, 11 diags., 2 tables, Sept. 1959, approx. 30 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. no. 58-51.

Phase equilibrium relations in the liquidus temperature region of the system CaO-iron oxide-SiO_2 in air were determined, using the quenching technique. The results are illustrated by means of a projection of the liquidus surface onto the composition triangle CaO-Fe_2O_3-SiO_2. A supplementary diagram is presented in order to indicate true compositions of liquids at liquidus temperatures. Data obtained in the present investigation are combined with literature data to construct diagrams showing stability relations among crystalline phases at subsolidus temperatures. A diagram is also presented to show phase relations along the join $CaO \cdot SiO_2$-$2CaO \cdot Fe_2O_3$. --Auth.

1-2540. Skinner, Brian J., Paul B. Barton, Jr., and Gunnar Kullerud. EFFECT OF FeS ON THE UNIT CELL EDGE OF SPHALERITE. A REVISION: Econ. Geology, v. 54, no. 6, p. 1040-1046, graph, 3 tables, Sept.-Oct. 1959, 9 refs.

The relationship between the unit cell edge of Fe-bearing sphalerites and their compositions has been redetermined. The equation relating the unit cell edge of sphalerite (a_o) to the FeS content is $a_o = 5.4093 + 0.000456X$, where a_o is in Angstrom units and X is mole percent FeS in solid solution in the sphalerite. This curve is significantly different from that determined by Kullerud, and the difference is believed to be due to the use of partially oxidized FeS in the original runs. If this supposition is correct, a little less Fe would substitute for Zn in ZnS than indicated by Kullerud. The difference between the solvus curve obtained by using unoxidized FeS and that obtained by using somewhat oxidized FeS may be significant, at least at high temperatures. This difference means the Kullerud's FeS-ZnS solvus must be used with caution when employed in determining high geologic temperatures, in particular those above 600°C. --Auth.

1-2541. Ellis, A.J. THE SOLUBILITY OF ZINC SULFIDE IN WATER AT HIGH TEMPERATURES: Econ. Geology, v. 54, no. 6, p. 1035-1039, 4 tables, Sept.-Oct. 1959, 17 refs.

From experiments, the solubility of zinc sulfide in water is less than 5 X 10^{-6} mole per kg. in the temperature range 200-300°C. This is an agreement with calculations from thermodynamic data. The transport of metal sulfides in hydrothermal solutions is briefly discussed, and thiosulfate complexes of heavy metals are suggested to be important agents in this respect. --Auth.

1-2542. Green, Jack. GEOCHEMICAL TABLE OF THE ELEMENTS FOR 1959: Geol. Soc. America, Bull., v. 70, no. 9, p. 1127-1183, graph, 2 fold. tables, Sept. 1959, approx. 1,000 refs.

The geochemical table of the elements for 1959 (with French, German, Russian, and Spanish keys), cast in the framework of the conventional periodic table, contains the following data for each element:

1) Geochemical character.

2) Weight and structure: atomic number, atomic weight, weight of 1 atom, and electronic-shell structure.

3) Size and charge: atomic, ionic, and miscellaneous radii, atomic and ionic volumes, lattice-energy coefficients, ionization potentials, and radius ratios. Ionic radii are adjusted for various co-ordinations of each ion.

4) Isotopic: naturally occurring isotopes with percent abundance, half lives, and type of radiation decay.

5) Nuclear: thermal neutron-capture cross section and nuclear spin in multiples of $h/2\pi$.

6) Thermodynamic: standard heat of formation (gas), standard free energy of formation (gas), logarithm of equilibrium constant (gas), and entropy at 25°C. (gas and solid).

7) Mineralogic: common or geochemically significant minerals with percent element contained.

8) Value: range of cost in United States dollars per unit weight or volume of reagent-pure element.

9) Abundances in grams per metric ton (printed in green overprint): abundances in sedimentary, metamorphic, igneous, and miscellaneous rock types (34 possible categories), in sea water (with transfer percentage), in Fe, sulfide, and silicate meteorite phases, and in the universe (including volatiles) are tabulated. Where possible, number of individual analyses and standard deviations for the arithmetic average are given as superscripts and subscripts respectively. Boldface indicates a general or global average; averages in lightface are local or specific with respect to area and/or time.

10) Series of geochemical interest: electromotive, oxidation-reduction, electrochemical equivalents, entropy of ions in aqueous solution, cation-field strength, ionic replacement, electronegativity, reaction, zoning, affinity for S in melt, solubility of sulfides, exchangeability in clays and hydroxide precipitation pH's. Ionic potential and co-ordination data are graphed.

A post-1953 bibliography of nonradiogenic isotope abundance data and a listing of abundances of elements in soils and igneous rocks, not included in the table, are included in the text. --Auth.

1-2543. Korzhinsky, D.S. HYDROTHERMAL ACID ALKALINE DIFFERENTIATION: Akad. Nauk SSSR, Proc., Geochemistry Sec., in translation, v. 122-123, no. 1-6, p. 83-85, Sept.-Dec. 1958, pub. 195 ref.

"Acid-alkaline hydrothermal differentiation, caused by an advance wave of acid components, lea ...to a redistribution of the substance not only with in the limits of the small volumes of each rock but also within the entire aureole of the influence of the postmagmatic solutions."--From auth. concl.

1-2544. Davidson, D.F., and H.A. Powers. SELE NIUM CONTENT OF SOME VOLCANIC ROCKS FRO WESTERN UNITED STATES AND HAWAIIAN ISLAN U.S. Geol. Survey, Bull. 1084-C, p. 69-81, 3 figs., 4 tables, Aug. 1959, 21 refs.

Eighty-one analyses for Se of volcanic rocks fro southern Alaska, the Aleutian Islands, the Hawaiia Islands, and several western states have been made as a part of a study of the geology and geochemistry of Se.

Of 15 samples from southern Alaska and the Aleu tian Islands, none contained more than 1 p. p. m. (part per million) Se; of 15 samples from the Hawai Islands, only 1, a crystal tuff, contained 3 p. p. m. Se, the others contained less than 2 p. p. m. Se. Of 52 samples from California, Colorado, Idaho, New Mexico, and Wyoming, only 6 contained 1 or more p. p. m. Se. Four of these were trachyte tuffs from Wyoming. The most seleniferous of these samples contained 40 p. p. m. Se, although analyses of this material have been reported as high as 500 p. p. m.

All seleniferous samples were of volcanic ash or rocks derived from volcanic ash. The writers suggest that crystalline volcanic rocks have lost, durin crystallization, the Se contained in the magma from which they are derived. Some noncrystalline volca ic rocks (for the most part ash) have retained at least a part of the Se. --Auth.

1-2545. Kretz, Ralph. CHEMICAL STUDY OF GA NET, BIOTITE, AND HORNBLENDE FROM GNEISSES OF SOUTHWESTERN QUEBEC, WITH EMPHASIS ON DISTRIBUTION OF ELEMENTS IN COEXIST ING MINERALS: Jour. Geology, v. 67, no. 4, p. 371-402, fold. map, 6 diags., 28 graphs, 4 tables, July 1959, 18 refs.

Grenville gneisses from a metamorphic terrain Quebec contain specific combinations of the major constituent minerals: quartz, potassium feldspar, plagioclase, sillimanite, garnet, biotite, hornblend calcium pyroxene, and rarely hypersthene. Garnet biotite, and hornblende from 29 rocks have been analyzed by spectrochemical methods; 62 mineral analyses are presented. The lithologic units assoc ated with the gneisses are briefly described.

An examination of mineral assemblages of Grenville gneisses has shown that certain minerals were found not to coexist. These relationships are discussed in terms of chemical equations. For examp the combination sillimanite-hornblende can be chem ically equated to the combination garnet-anorthite-quartz-H_2O. The combinations sillimanite-garnet-anorthite-quartz and hornblende-garnet-anorthite-quartz commonly occur in the gneisses, but all min erals of the equation have not been found to coexist

It was found that the concentrations of some elements in garnet and biotite appear to be restricted by the coexistence of certain other minerals. These relationships are discussed in terms of chemical reactions. For example, garnets which coexist with sillimanite contain from 1.59 to 3.74% grossularite, while those which are not accompanied by sillimanite contain from 5.2 to 23.0% grossularite. The cause of this restriction is considered to lie in the reaction grossularite (in Fe-Mg-Mn garnet) + sillimanite + quartz $\rightleftharpoons$ anorthite (in plagioclase). A tentative phase diagram is presented.

It was found that some of the elements Fe, Mg, Mn, Ti, V, Cr, Zr, Y, and Sc are regularly distributed among coexisting garnet, biotite, and hornblende. The distribution of an element between 2 minerals is examined by the use of a distribution diagram (Roozeboom diagram). Regular distributions have the following forms:

1. The distribution coefficient can be expressed by a simple ratio. For example: (Mn/Fe + Mg + Mn in garnet) / (Mn/Fe + Mg + Mn + Ti in biotite) = constant. Distributions of this kind are in agreement with Nernst's distribution law.
2. The distribution of an element between 2 minerals is dependent on the concentration of another element in one of the minerals. For example: (weight percent V_2O_3 in garnet) / (weight percent V_2O_3 in biotite) $\approx f$ (Ca/Fe + Mg + Mn + Ca in garnet).
3. The distribution is expressed by a curved line on the distribution diagram. For example: (Mn/Fe + Mg + Mn in garnet) plotted against (Mn/Fe + Mg + Mn + Ti in hornblende) produces a number of points which define a curved line intersecting the origin.

Irregular distributions of some elements have been found; possible causes of the irregularities are discussed. All the relationships that were found in the Grenville gneisses are in agreement with the principles of chemical-phase theory. Relationships of this kind should exist in multiphase chemical systems at equilibrium. It is concluded that the minerals of the gneisses experienced a time of chemical communication and closely approached a state of chemical equilibrium. --Auth.

1-2546. Laevastu, Taivo and Thomas G. Thompson. SOLUBLE IRON IN COASTAL WATERS: Jour. Marine Research, v. 16, no. 3, p. 192-198, 3 tables, Oct. 1958, pub. 1959, 16 refs.; also pub. as: Washington, Univ., Dept. Oceanography, Contr. no. 222.

Soluble Fe, defined as the amount of the element found in a unit volume of millipore-filtered sea water, after oxidation of organic matter, has been determined on samples collected in inshore waters of the state of Washington. After filtration the samples were oxidized. The particulate matter and its Fe content were also determined. Bathophenanthrolene was the reagent used.

Analyses showed a variation in soluble Fe ranging from 5.5 to 32 μg/l; the particulate matter varied from 700 to 2,000 μg/l and contained from 2.8 to 13.3% of Fe. While the general conclusions on the distribution of Fe in the waters of Washington may be valid, such values for soluble Fe are high in the light of recent studies by Lewis and Goldberg. --Auth.

1-2547. Dobrzhanskaya, M.A. and T.I. Pshenina. SOME DATA ON THE CONTENT AND DISTRIBUTION OF IRON IN THE BLACK SEA: Akad. Nauk SSSR, Proc., Geochemistry Sec., in translation, v. 122-123, no. 1-6, p. 91-93, graph, 3 tables, Sept.-Dec. 1958, pub. 1959, 5 refs.

The results on the determination of the dissolved and suspended fractions of Fe from Black Sea samples is given in tabular form under the following general headings: content of dissolved Fe at various depths; suspended Fe content at various depths; distribution of Fe in the oxygen zone; and variations in the Fe and phosphate contents. --M. Russell.

1-2548. Bieri, Robert and David H. Krinsley. TRACE ELEMENTS IN THE PELAGIC COELENTERATE, *VELELLA LATA*: Jour. Marine Research, v. 16, no. 3, p. 246-254, table, Oct. 1958, pub. 1959, 12 refs.

Twelve elements (Cu, Ni, Mn, Ti, Si, Cr, Sr, V, Ba, Ag, Pb, and Mo), not preveiously reported from the genus *Velella*, were found in the ash of *V. lata*; Zr was also searched for but was not found. Cu, Ni, Mn, Ti, Mg, Ca, and Al were determined quantitatively. The concentration of trace elements in the whole animal and in 5 different tissues of *V. lata* was determined in specimens ranging from 14.4 to 84.6 mm. in length. The Mg:Ca ratio in *Velella* is lower than that in sea water but higher than that in Scyphozoa. Presumably this is due to concentration of Mg in the chlorophyll of commensal zooxanthellae. --Auth.

1-2549. Samuel, David, and Fritz Steckel, comps. and eds. BIBLIOGRAPHY OF THE STABLE ISOTOPES OF OXYGEN (O^{17} AND O^{18}): 224 p., New York, Pergamon Press, 1959.

This bibliography contains a complete record of papers (approx. 725) published on this subject up to the end of 1957. Work on nuclear reactions has not been included unless other data of interest are reported. The bibliography consists of an author index and a subject index. The author index includes the full bibliographical reference for each paper, the place where work was done (if known), and, where possible, the Chemical Abstracts reference number. Each entry is identified by a letter-number symbol. The subject index lists both general subjects and individual compounds. The nomenclature adopted by Chemical Abstracts is used, with a few variations in order to keep similar compounds in a group. Esters and salts are listed alphabetically, under the acid radical or anion. The words "isotope" or "oxygen-18" are not used when the meaning is clear. All papers dealing with oxygen-17 are listed under this heading. The symbol O^{18} after the full name of the compound indicates uniform labelling of all O atoms. Each entry in the subject index is followed by the letter-number symbols referring to the relevant papers in the author index. These symbols are preceded by the last 2 figures of the year of publication and arranged in chronological order to indicate the date of publication. --From auth. introd.

1-2550. Vinogradov, A.P. GEOCHEMISTRY OF ISOTOPES. Translated by V.P. Sokoloff: Internat. Geology Rev., v. 1, no. 8, p. 1-13, illus., map, 4 graphs, 4 tables, Aug. 1959.

The isotopic composition of the earth's crust is never static, due to various radioactive processes. This is especially noticeable on geologic time scales. The isotopic exchange reactions, particularly those involving lighter atoms, are intensive in the outer shell of the earth, notably in the biosphere. The biospheric exchange reactions are primarily responsible for local enrichments and anomalous absences of various isotopes, especially those of O, C, S, and H. Isotope geochemistry is a tool which will help solve problems of past major and minor geologic events in the genesis of rocks and minerals. It is hoped that isotope geochemistry will introduce 2 new parameters into geologic investigation of time and temperature of natural processes. --G. E. Denegar.

1-2551. Teis, R.V., T.S. Gromova, and S.N. Kochetkova. THE ISOTOPIC COMPOSITION OF NATURAL PHOSPHATES: Akad. Nauk. SSSR, Proc., Geochemistry Sec., in translation, v. 122-123, no. 1-6, p. 87-90, 2 graphs, 3 tables, Sept.-Dec. 1958, pub. 1959, 9 refs.

"There is a difference between bonds with the isotopic composition of the oxygen of water, sulfates, and phosphates. In the majority of cases natural sulfates (gypsums) belonging to compounds which slowly exchange their oxygen with water have a composition approximating equilibrium with the oxygen of river water, whereas the oxygen of natural phosphates is considerably different from it. In part of the samples this depends on another origin not connected with water. In those instances where an association with water can be assumed this evidently depends firstly on the fact that phosphates exchange their oxygen with water still less readily than sulfates, in the second place, possibly on the fact that potassium salts of phosphates are less soluble than the sulfates."--From auth. concl.

1-2552. Hendler, Richard W. SELF-ABSORPTION CORRECTION FOR CARBON-14: Science, v. 130, no. 3378, p. 772-777, 5 graphs, table, Sept. 25, 1959, 9 refs.

A new and simple technique has been developed for correcting C^{14} radioactivity measurements for loss of radiation due to self-absorption. Results are discussed which show the applicability of the technique for many different counting situations. It is found that the absorption of radiation follows a hyperbolic law much more closely than an exponential one. Furthermore, the absorption coefficient for the sample itself has been found to be a function of weight rather than a constant, as had been assumed for the derivation of the law of exponential absorption. --Auth.

1-2553. Yakubova, V.V. AN ATTEMPT AT STUDY OF INCLUSIONS IN MINERALS OF MURZINKA (URAL) PEGMATITES. Translated by V.P. Sokoloff: Internat. Geology Rev., v. 1, no. 8, p. 52-66, 20 illus., 2 tables, Aug. 1959, 18 refs.

Direct determination of temperatures of development of pegmatites of Murzinka, in the Urals, by homogenization of inclusions in minerals is scarcely possible. In places where nourishment of the crystal is impaired, not only one, but several, inclusions develop, regardless of the mechanisms responsible for impairment. Such groups of inclusions may represent single systems in disequilibrium or several generations of heterochronic inclusions. The degree of equilibrium depends on the degree of solubility of the mineral substance in the medium captured. Phase ratios may be disturbed in the course of reorganization within primary inclusions. --G. E. Denegar.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Areal and Regional Geology 1-2443, 1-2445; Sedimentary Petrology 1-2574, 1-2575.

1-2554. Buerger, Martin J. VECTOR SPACE AND ITS APPLICATION IN CRYSTAL-STRUCTURE INVESTIGATION: 347 p., illus., tables, New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1959, refs.

This book is intended for academic and professional use by crystallographers, mineralogists, physicists, chemists, and metallurgists. Subjects covered include: the phase problem of X-ray crystallography, the Patterson function, some early intuitive use of Patterson maps, further theory of Patterson functions, Patterson functions for special cases, Patterson projections of symmetrical crystals, Harker sections and implication theory, sets of discrete points and their vector sets, symmetry in vector space, theory of image-seeking functions, superposition functions, the use of image-seeking functions in projections, the use of image-seeking functions in 3 dimensions, substructures, and retrospectus.--L. M. Dane.

1-2555. Hellner, Erwin. AN INTERGROWTH BETWEEN GALENA AND GRATONITE ($Pb_9As_4S_{15}$): Jour. Geology, v. 67, no. 4, p. 473-475, 2 illus. on pl., fig., July 1959, 5 refs.

An intergrowth between galena and gratonite is described, which can be accounted for by the structural relationship of these 2 minerals. The body diagonal of the galena cube is nearly parallel to the c-axis of gratonite; the deviation from parallelism is a result of the structural distortion of gratonite from cubic symmetry. --Auth.

1-2556. Karkhanavala, M.D., and A.C. Momin. THE ALTERATION OF ILMENITE: Econ. Geology, v. 54, no. 6, p. 1095-1102, diag., graph, 3 tables, Sept.-Oct. 1959, 7 refs.

The alteration of ilmenite in air due to oxidation at elevated temperatures has been studied. The final product of oxidation at 850°C. was found to be a mixture of hematite, pseudobrookite, and rutile in an approximate molar ratio of 1:5:7. This product is almost identical with naturally occurring "brown leucoxene." At lower temperatures (650°C.) a mixture of hematite with probably some rutile and an as yet unidentified phase was obtained. From color changes as well as from thermogravimetric analysis, it was observed that slow oxidation could take place at temperatures of even 100° and 200°C. The oxidation products were weakly paramagnetic, and for products heated for equal periods, the susceptibility decreased with increasing temperature of oxidation. --Auth.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Stratigraphy 1-2472; Geochemistry 1-2543, 1-2544; Mineral Deposits 1-2601.

1-2557. Lyon, R.J.P., W.M. Tuddenham, and C.S. Thompson. QUANTITATIVE MINERALOGY IN 30 MINUTES: Econ. Geology, v. 54, no. 6, p. 1047-1055, diag., 4 graphs, 2 tables, Sept.-Oct. 1959, 11 refs.

A common basis of petrographic descriptions of acid igneous rocks rests upon the quantitative determination of quartz content and feldspar types and contents. With these fundamental determinations almost all of these igneous rocks may be placed in their correct categories. In general, the quantitative determination of the ferromagnesian and other accessory minerals is not essential to the classification of these rocks. Much of this basic information necessary for rock classification is now obtained at the Kennecott Research Center by use of the infrared spectrophotometer. From standard calibration curves obtained by using individual pure minerals, and with the aid of synthetic mixtures of the diagnostic minerals, the quantities and types of minerals present in the unknown samples can be rapidly determined. To test the validity of the analytical results obtainable by this method, the standard granite (G-1) was used, which had been originally prepared and distributed as a powder by the U.S. Geological Survey for spectrographic and chemical analyses. This, therefore, constituted a good rock sample whose mineralogical composition was known, and was particularly useful as most igneous rocks associated with ore bodies are of this acidic type - granites, granodiorites, monzonites, and quartz monzonites.--Auth.

10. SEDIMENTARY PETROLOGY

See also: Paleontology 1-2486; Geophysics 1-2531.

1-2558. Altschaeffl, A.G. and W. Harrison. ESTIMATION OF A MINIMUM DEPTH OF BURIAL FOR A PENNSYLVANIAN UNDERCLAY: Jour. Sed. Petrology, v. 29, no. 2, p. 178-185, diag., graph, table, June 1959, 24 refs.

A sample of Upper Block underclay (middle Pennsylvanian) was taken near Brazil, Indiana, and its void ratio was determined in the laboratory. By dispersing, resedimenting, and reconsolidating the underclay in the laboratory, it was possible to estimate the stress cycle required to consolidate the underclay to its present void ratio. The maximum-stress value determined from the estimated stress cycle was translated into a thickness value of overlying, subaqueous sediments. Results of this initial study permit the estimate that the underclay was once buried under at least 4,500 ft. of subaqueous sediments, and that at least 3,700 ft. of Pennsylvanian or post-Pennsylvanian sediments have been eroded in this region of the Illinois basin. The depth-of-burial estimate is considered to be a minimum one because the systematic increase in void ratio (bed thickness) toward the surface of the reconstructed sediment column has not been taken into account.--Auth.

1-2559. Hayes, John R., and Michael A. Klugman. FELDSPAR STAINING METHODS: Jour. Sed. Petrology, v. 29, no. 2, p. 227-232, 3 graphs, 4 tables, June 1959, 9 refs.

A feldspar staining technique, based upon the method described by Gabriel and Cox, was tested for accuracy and reliability by using both artificial mixtures of quartz and feldspar, and natural sands. The sand grains are mounted on a glass slide, exposed to the fumes of hydrofluoric acid for 15 min., treated with a concentrated solution of sodium cobaltinitrite for 2 min., rinsed, and dried. This reaction forms a yellow coating on the potash feldspars, a white coating on the soda-lime feldspars, and the quartz is not affected. For greater accuracy, the sample may then be treated for a few minutes with a 0.5% solution of eosine "B." This will stain the soda-lime feldspars pink and the potash feldspars orange-yellow.

Tests on 70 slides of artificial mixtures of quartz and feldspar show that the method is accurate to plus or minus 5%. Percentages determined by multiple tests on natural sands show good agreement, usually to within 5%.--Auth.

1-2560. O'Neil, Robert L. ANALYTICAL PROCEDURES APPLICABLE TO FINE-GRAINED SEDIMENTARY ROCKS: Jour. Sed. Petrology, v. 29, no. 2, p. 267-280, table, June 1959, 23 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. no. 57-75.

Methods are described for the determination of major and minor chemical constituents in fine-grained sedimentary rocks. They include wet-chemical methods, radiometric and flame-photometric methods, absorption and emission spectroscopic methods, and fluorescent X-ray procedures. The major elements are determined by a rapid semi-micromethod on 2 samples, one of which is decomposed by fusion with sodium carbonate; the other sample is decomposed by digestion with sulfuric and hydrofluoric acids. Trace elements are determined by spectrochemical procedures using internal standards. C, S, and the C present in carbonate minerals are determined by conventional methods.

A fluorescent X-ray spectroscopic method for Fe and Mo is described.--Auth.

1-2561. Simmons, Gene. THE PHOTO-EXTINCTION METHOD FOR THE MEASUREMENT OF SILT-SIZED PARTICLES: Jour. Sed. Petrology, v. 29, no. 2, p. 233-245, 3 diags., 6 graphs, table, June 1959, 18 refs.

The photo-extinction method for small particle analysis depends on the absorption of light by silt-size particles in suspension. The rate of change of absorption in a sedimentation cell is related by Stokes' law to the particle diameter. By the use of graphical integration, continuous size distribution curves were constructed for samples of silt, loess, and volcanic ash. In order to compare the photo-extinction method with the more familiar pipette, hydrometer, and microscope methods, samples of the loess were analyzed using the 4 techniques. Results obtained with the photo-extinction method are reproducible, compare favorably with data obtained by use of the standard microscope method, and are superior to results obtained by either the pipette or hydrometer method.--Auth.

1-2562. van Andel, Tj. H. REFLECTIONS ON THE INTERPRETATION OF HEAVY MINERAL ANALYSES: Jour. Sed. Petrology, v. 29, no. 2, p. 153-163, 3 figs., table, June 1959, 37 refs.

The study of heavy minerals, an important field of endeavor for the sedimentary petrographer prior to 1940, has declined in recent years. This decline, caused primarily by the disappointing results of heavy mineral correlation, is regrettable because in regional stratigraphic and paleogeographic research the method is capable of contributing important information concerning the location and character of source areas and the distribution patterns of sediments. The following factors can modify the heavy mineral composition and limit the interpretation of the assemblage in terms of source area conditions: 1) weathering, 2) abrasion, 3) selective sorting, and 4) post-depositional solution. This paper attempts to show that 3) and 4) are of minor importance. In basins with a low rate of sediment supply and under conditions of intense weathering and reworking, the others can strongly modify the composition of the heavy mineral assemblage. In basins of rapid deposition deriving their sediment in general from source areas with active erosion, the influence of all factors is negligible, and the heavy mineral assemblage directly reflects the petrography of the source area. An example illustrates the type of problem for which heavy mineral analysis is of value. Problems of sediment source and distribution in the Mississippi Valley and the Gulf Coastal Plain in the Cenozoic are a field where heavy mineral analysis is considered rewarding. --Auth.

1-2563. Smith, Alec J. DESCRIPTION OF THE MACKERETH PORTABLE CORE SAMPLER: Jour. Sed. Petrology, v. 29, no. 2, p. 246-250, illus., 2 diags., June 1959, ref.

The Mackereth core sampler is a portable corer capable of collecting fine-grained bottom samples from lakes and shallow seas at depths up to 300 ft. At the sampler's present stage of development, cores up to 20 ft. in length with a diameter of 1 1/2 in. can be collected. The corer operates as a piston which is pushed into the sediments by compressed air. The corer is held on the surface of the sediment for the duration of the coring operation by the hydrostatic pressure. When the sample has been taken the corer is raised to the surface by means of compressed air. --Auth.

1-2564. Tanner, William F. THE IMPORTANCE OF MODES IN CROSS-BEDDING DATA: Jour. Sed. Petrology, v. 29, no. 2, p. 221-226, 6 figs., June 1959, 20 refs.

Cross-bedding data are presented from 3 sharply restricted channel sandstones, in Oklahoma and Tennessee, from a Pleistocene deposit in Florida, and from the Pottsville sandstones of parts of Kentucky, Tennessee, Georgia, and Alabama. Modal vectors are shown to be more useful in certain instances for paleogeographic purposes than vector sums. Pottsville cross-bedding data appear to be essentially trimodal, with the 3 modes at right angles to each other. The "minimum direction" is approximately the direction toward the Appalachian source land. Asymmetry of the data indicate that littoral currents flowed more readily toward the S. than toward the N. A measure of dispersion (n/R) for modal vectors is used to produce a crude map of Pottsville regional slope in northeastern Alabama. --Auth.

1-2565. Sullwold, Harold H., Jr. NOMENCLATURE OF LOAD DEFORMATION IN TURBIDITES: Geol. Soc. America, Bull., v. 70, no. 9, p. 1247-1248, 6 illus., Sept. 1959, 3 refs.

The use of "load casts" for structure resulting from a load of sand pressing unevenly into underlying mud has serious shortcomings. The terms load pocket, load wave, and load fold are proposed for equal status with load cast. The load pocket is the bulge of sand pressing into the underlying stratum. The load wave is the salient curved unevenness of underlying material which appears to have been squirted up into the superjacent turbidity-current deposit. The load folds are plications in the laminae of the underlying stratum which are the result of pressure from the unequal load of the overlying load pockets and waves. --M. Russell.

1-2566. Brown, W.W.M. THE ORIGIN OF STYLOLITES IN THE LIGHT OF A PETROFABRIC STUDY: Jour. Sed. Petrology, v. 29, no. 2, p. 254-259, 4 illus., pl., June 1959, 9 refs.

Petrofabric analysis of authigenic quartz crystals in stylolites from Carboniferous limestone in North Wales has been undertaken. The results obtained support Stockdale's "pressure-solution" theory. --Auth.

1-2567. Heald, Milton T. SIGNIFICANCE OF STYLOLITES IN PERMEABLE SANDSTONES: Jour. Sed. Petrology, v. 29, no. 2, p. 251-253, table, June 1959, 6 refs.

The occurrence of stylolite seams in permeable sandstones indicates that solution is localized by the material in clay partings rather than by freer circulation along bedding planes. Cementation may be commonly related to stylolite formation as the dissolved material may be redeposited within the bed to form the cement. --Auth.

1-2568. Inderbitzen, Anton L. GRAVELS OF ALAMEDA CREEK, CALIFORNIA: Jour. Sed. Petrology, v. 29, no. 2, p. 212-220, map, 3 graphs, 3 tables, June 1959, 11 refs.

The purpose of this study was to determine if data on the recent sediments of Alameda Creek, Alameda County, California, supported the general observation that the size of stream sediments decreases with increasing distance from the stream's headwaters. Beginning at the stream's headwaters on Valpe Ridge and continuing 18 mi. to the town of Niles, consecutively numbered observation stations were set up at mile intervals. At each station the size, rock type, roundness, and sphericity of the maximum-sized boulder were determined. Also at observation stations 2, 5, 7, and alternate stations thereafter, 200 rocks were measured to determine the size distribution of the gravel. Volume frequency and cumulative percentages were computed from the numerical data.

It was found that the maximum boulder size fluctuates throughout the entire length of the stream studied. but generally decreases as distance from the headwaters increases. The fluctuations seem to be due to constrictions in the width of the stream channel and changes in the stream gradient. The median diameter graph is very similar to the maximum-boulder-size graph. The sediments appear to be well sorted. Sphericity of the maximum-sized boulder fluctuates, whereas the roundness increases as the distance from the headwater increases. In general, the data on recent sediments of Alameda Creek support the observations made on other streams and have no major anomalies. --Auth.

1-2569. Carozzi, Albert V. and Valentine E. Zadnik. MICROFACIES OF WABASH REEF, WABASH, INDIANA: Jour. Sed. Petrology, v. 29, no. 2, p. 164-171, 6 figs. incl. sec., graphs, June 1959, 7 refs.

The microscopic statistical investigation of the Wabash reef has revealed 5 main microfacies ranging, in decreasing relative depth conditions, from highly dolomitic shales of the country-rock to dolomitic biocalcarenites and bioconstructed dolomitic limestones or dolomites belonging to the reef system. Among the microscopic parameters, the variation of the orientation of siliceous monoaxonic sponge spicules in the shales can be used as a criterion for predicting the position of the reef. --Auth.

1-2570. Shepard, Francis P. and Robert R. Lankford. SEDIMENTARY FACIES FROM SHALLOW BORINGS IN LOWER MISSISSIPPI DELTA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 9, p. 2051-2067, 6 figs. incl. illus., 2 maps, secs., graph, Sept. 1959, 17 refs.

Detailed analyses of the marginal sediments of the Mississippi delta have permitted the development of criteria for recognizing deltaic environments. In order to test the use of these criteria as a means of improving the interpretation of older sediments, 6 borings were jetted into the lower delta to depths up to 45 ft., and the continuous samples along these borings were given intense study. The Foraminifera, the constituents of the coarse fractions, the grain-size parameters, and the sedimentary structures served to diagnose the environments in which most of the sediments were deposited.

A boring into the end of Baptiste Collette subdelta showed at least 3 alternations between sound and deltaic deposits. A boring into outer Main Pass, where the water was 26 ft. deep in 1860, showed the advance of the delta over the sound facies. The boring into the end of North Pass is interpreted as showing the muddy fill of an abandoned pass overlying a laminated river-mouth bar, which in turn overlies a probable barrier-island deposit. The other borings into the birdfoot delta pass through deposits characteristic of interdistributary bays and of the platforms bordering the delta margin, but do not reach the clayey foreset beds beyond the delta margin.

The borings cast doubt on the concept of bar-finger "sands" forming in front of the advancing deltaic lobes in the birdfoot delta. The sediments encountered were no sandier than those off the present mouths which consist predominantly of silt and clay. The only place where a clean sand was penetrated which could be compared with the thick sand sections shown in lower delta borings by the U.S. Army Engineers yielded sediment differing from that of the present-day river-mouth bars. More borings with detailed studies of the core samples are needed before accepting or rejecting the bar-finger "sand" interpretation. --Auth.

1-2571. Brown, C.W. DIAGENESIS OF LATE CAMBRIAN OÖLITIC LIMESTONE, MAURICE FORMATION, MONTANA AND WYOMING: Jour. Sed. Petrology, v. 29, no. 2, p. 260-266, 5 illus., map, 2 tables, June 1959, 23 refs.

Dolomitization of Late Cambrian oölitic limestone in the Maurice formation followed lithification and preceded regional fracturing of the rock. The source of Mg-rich dolomitizing solutions is believed to have been connate waters from adjacent argillaceous sediments. Regional compaction forced these waters into the permeable oölite sands of the Maurice formation. Fluid migration and subsequent dolomitization were controlled by effective porosity trends essentially parallel to bedding. Aragonitic oölite nuclei formed natural foci for dolomitization. --Auth.

1-2572. Payton, Charles E., and Leo A. Thomas. THE PETROLOGY OF SOME PENNSYLVANIAN BLACK "SHALES": Jour. Sed. Petrology, v. 29, no. 2, p. 172-177, 4 figs. incl. secs., graphs, table, June 1959, 3 refs.

Black fissile "shales," from some Missourian and Virgilian cyclothems of central Iowa and eastern Nebraska have been analyzed to determine their chemical and physical properties, the stratigraphic, petrographic, and paleontologic successions over wide geographic areas, and the environment of deposition suggested by these parameters.

The stratigraphic succession commonly consists of 3 basic elements: a lower black fissile siltstone; a medial black "varved" siltstone; and, an upper gray to gray-green shaly siltstone.

Organic contents range from 2 to 26%. Acid-soluble contents range from 11 to 38%. An inverse relationship between organic content, fissility, and radioactivity occurs.

Petrographically, the silts are predominantly quartz, with lesser amounts of illite, kaolinite, vermiculite, pyrite, and carbonates. The siltstones have an average mineral composition within the range of sub-graywacke to graywacke. Sorting coefficients range from 1.9 to 4.3. No general trend in the degree of sorting is apparent.

A definable stratigraphic, petrographic, and paleontologic succession occurs and can be traced over a wide geographic range. The stratigraphic and paleontologic characteristics, as well as many other features, have their closest association with modern tidal flat deposits. The deposits apparently accumulated in both regressive and transgressive seas. The cyclothem boundary occurs within these black silt intervals. --Auth.

1-2573. Blatt, Harvey. EFFECT OF SIZE AND GENETIC QUARTZ TYPE ON SPHERICITY AND FORM OF BEACH SEDIMENTS, NORTHERN NEW JERSEY: Jour. Sed. Petrology, v. 29, no. 2, p. 197-206, 4 diags., graph, table, June 1959, 8 refs.

Sphericity has been determined on quartz grains from beach sediments of northern New Jersey to determine its variation with size and genetic quartz type in a beach environment. Within the size range studied, -5ϕ to $+4\phi$, sphericities increased from a minimum of .59 at -4.5ϕ (22 mm.) to a maximum of .85 at $+0.9\phi$ (0.55 mm.), and then decreased again to .76 at $+3.4\phi$ (0.10 mm.).

It appears certain that both size, as such, and genetic quartz type, influence sphericity values, but their relative importance is uncertain. The size range in which the control of quartz type on sphericity appears best developed and most noticeable is between -1.5ϕ and $+1.0\phi$. In coarser grains, either sphericity when released from the parent rock, or mode of abrasion, seems to assume greatest importance. Coarser sizes consist very largely of vein quartz, which may have an inherently low sphericity. In finer sizes sphericity decreases, apparently independently of quartz type.

Comparison with river pebbles from both the Aftonian Bridgeton formation in northern New Jersey, and the present Colorado River (Texas) sediments, indicates that the beach pebbles tend to be more discoidal and the fluvial pebbles more rodlike in sizes coarser than -2.5ϕ (about 6 mm.). In gravel sizes finer than this, grains from the 2 environments are apparently indistinguishable by form. Sand grains of the beach samples studied have a rodlike tendency. --Auth.

1-2574. Rogers, John J.W., and Henry C. Adams, Jr. **THE MINERALOGY AND TEXTURE OF BEACH SANDS OF GALVESTON ISLAND, TEXAS:** Jour. Sed. Petrology, v. 29, no. 2, p. 207-211, 2 graphs, 5 tables, June 1959, 5 refs.

Relative proportions of individual heavy minerals in the front- and back-bar beaches of Galveston Island are almost identical and indicate little or no compositional difference between the 2 beaches. Size distributions of the bulk sands from the 2 beaches, however, show marked differences. Sands of the back beach contain an excess of fine material over the amount predicted from lognormal curves; sands of the front beach exhibit a deficiency of fine sizes, with the deficiency most pronounced in the intermediate (0.1 mm.) range. The distribution curves are apparently the result of selective reworking of original shoreline sands. The textural features are controlled by local depositional environments on the bar, but compositional properties are apparently independent of these local environments. --Auth.

1-2575. Franks, Paul C., and Ada Swineford. **CHARACTER AND GENESIS OF MASSIVE OPAL IN KIMBALL MEMBER, OGALLALA FORMATION, SCOTT COUNTY, KANSAS:** Jour. Sed. Petrology, v. 29, no. 2, p. 186-196, sec., 4 graphs, 5 tables, June 1959, 21 refs.

Chemical analyses, weight-loss studies, differential thermal analyses, and X-ray diffraction studies show that massive opal in the Kimball member of the Ogallala formation, like opal described by Flörke, is composed of hydrated low-cristobalite that is disordered by differing amounts of low-tridymite, which forms an integral part of the opal structure. The development of tridymite structure in the opal, as proposed by Flörke, is due to incorporation of cations (e.g., Na^+, K^+, Ca^{+2}, and Al^{+3} among others) into the low-cristobalite structure. It is proposed that the Kimball member, which is everywhere rich in feldspar and quartz, was leached during formation of the overlying pisolitic caliche, freeing SiO_2 and metal cations which were redeposited as opal having a disordered low-cristobalite structure. Difference in hardness of opal samples is seemingly inversely related to difference in water content; the more hydrated samples have lesser hardness. --Auth.

11. GEOHYDROLOGY

See also: Geophysics 1-2535, 1-2536; Geochemistry 1-2537.

1-2576. Hantush, Mahdi S. **NONSTEADY FLOW TO FLOWING WELLS IN LEAKY AQUIFERS:** Jour. Geophys. Research, v. 64, no. 8, p. 1043-1052, 2 diags., graph, 3 tables, Aug. 1959, 10 refs.

Potential distribution is found for a flowing well discharging by natural flow from a uniform aquifer into, and/or out of, which there is leakage in proportion to the drawdown. The leaky aquifer is of uniform compressibility and of uniform transmissibility. Three cases are considered: 1) that of a well draining an infinite leaky aquifer; 2) that of a well at the center of a circular aquifer with zero drawdown on its outer boundary; 3) that of a well situated at the center of a closed circular aquifer (that is, the flow across the outer boundary is zero). The variation of the discharge with time is formulated in the 3 cases. The drawdown distribution and the discharge variation for the corresponding systems of nonleaky aquifers are obtained. It is shown how the formation constants (the coefficient of transmissibility, the coefficient of storage, and the coefficient of leakage) are obtained from variations in the rate of discharge of wells flowing at constant drawdown. --Auth.

1-2577. von Buttlar, Haro. **GROUND-WATER STUDIES IN NEW MEXICO USING TRITIUM AS A TRACER, II:** Jour. Geophys. Research, v. 64, no. 8, p. 1031-1038, 2 maps, 6 graphs, 7 tables, Aug. 1959, 7 refs.

The monitoring of the tritium concentration of rain-water and ground-water samples in New Mexico has been continued. A third peak in the rain water was found in the summer of 1957. By comparison of the tritium content of a ground-water sample with that of the rain water, hydrologic quantities such as the age and velocity of flow of the ground water could be determined. The tritium method shows considerable promise as a hydrologic tool. --Auth.

1-2578. U.S. Atomic Energy Commission, Knolls Atomic Power Laboratory. **HYDROLOGIC AND TRACER STUDIES IN MOHAWK RIVER AT KNOLLS ATOMIC POWER LABORATORY,** by Eugene S. Simpson, W.A. Beetem, F.H. Ruggles, Jr., and others. Prepared by the U.S. Geological Survey in cooperation with the U.S. Atomic Energy Commission: Its: [Pub.] SO-45, 285 p., 62 figs. incl. illus., maps, secs., profiles, graphs, 63 tables, Albany, New York, U.S. Geological Survey, July 1959, 21 refs.

An investigation of the hydraulic and hydrologic characteristics of the area near the Knolls Atomic Power Laboratory (KAPL) was undertaken to determine the probable effect of release of low concentration radioactive waste from the Laboratory to Mohawk River. This report describes that investigation.

The area of primary interest during the course of the investigation was Niskayuna Pool, about 15 mi. upstream from the confluence of Mohawk and Hudson rivers. The pool was formed for navigation, but the fall of water from the pool is also utilized for power production. During periods of low flow, discharge from the pool and past the Knolls is regulated almost entirely by power-plant operation. Below the Knolls, water from the Mohawk is utilized by the city of Cohoes, a few industrial firms, and for navigation and power production.

Field work was begun in 1948. However, hydrologic data had been gathered at other points in the Mohawk basin for many years prior to 1948. In this report, data on mean flow, flow duration, frequency of floods and of periods of low flow, based on a record for the period 1926-1955 of Mohawk River at Cohoes and other points are presented. A continuous record of river stage was obtained at the Knolls beginning in 1948, and is useful as an adjunct to the Cohoes record. However, the stage at the Knolls bears no direct relationship to discharge except during extreme high water. The record is presented, in both graphic and tabular form, for the years 1948 to 1955. Discharge measurements have been made at various sections in Niskayuna pool, and the velocity distribution at those times is shown graphically. A chart of the pool, compiled from the measurements from canal maintenance charts, and from other sources, is presented. Discharge from Niskayuna pool during periods of low flow may frequently approach zero for short periods of time, but the mean daily discharge at Vischer Ferry Dam averages closely to that at Cohoes. The studies at Cohoes are considered indicative of conditions in the long range at the Knolls.

Flood stages have been recorded at Vischer Ferry Dam since 1914, and would appear to pose no threat to installations at the Knolls, although the possibility of excessive backwater from ice jams exists every winter, and the potentialities of damage from this source are unpredictable.

During the period 1951 to 1956, data on the chemical quality, temperature, and radioactivity of surface and ground waters in the area were collected. Investigations of sediment and bed material of Mohawk River in the vicinity of Knolls were performed. Water from the Mohawk contains principally calcium bicarbonate, and small amounts of other minerals commonly present in natural waters. The mineral content during the study was moderate. Concentrations vary with discharge, but do not follow discharge fluctuations as closely as might be expected, perhaps because of impoundment of the water in reservoirs in the basin. The pH of the water was slightly higher than 7.0. The ground waters have considerable carbonate hardness. The concentration of dissolved mineral matter is greater in water from deeper wells than from the shallow. Radioactivity of surface and ground waters, rainwater, sediment, and bed material was measured; radioactivity from fallout resulting from nuclear weapons tests is reflected in some of the data presented.

Periodic observations of temperature of Mohawk River are presented in graphic form. The observed extremes of temperature of the river water were 32° and 85°F., with the average ranging between 33° and 77°F. Temperatures of ground water not affected by induced recharge averaged within a few degrees of 50°F. throughout the year.

Sediment samples taken at various points in Mohawk River showed a large percentage of silts and clays and a small percentage of sand. Predominant minerals were hydrous mica and quartz. Total sediment loads under various conditions are tabulated. Bed materials were sampled, and the results of analyses show a trend to diminution of particle size as river control structures are approached from upstream. Maps of Niskayuna Pool for the period 1909-1954 indicate considerable deposition of sediment.

Studies were made of the path and dilution characteristics of tracer substances, introduced into Mohawk River at the Knolls sewer outfall. Brine and fluorescein were the first tracers used. The results were inconclusive, but were of value in establishing procedures used in later trials. Three radioactive tests were conducted, in 1953 and 1954, using the isotope, P-32. Methods of tracer introduction and of instrumentation were developed for the particular conditions of the tests. The tests indicated that the initial path and dilution of the isotope were sensitive to difference in density between conveying medium and river water.

In test 3, the most definitive results were obtained. At the time of test 3 (Aug. 9, 1954) the temperature of the sewage was lower and density was higher than that of the river water. The logarithm of maximum concentration of radioactivity was found to be negatively proportional to the distance the isotope-laden sewage had traveled from the sewer outfall. The term "concentration half distance" is proposed to express the concentration/distance relationship which reduces concentration by one-half. Under the conditions of test 3, this half distance was in the order of 100 ft., over a path of about 800 ft. in length. Measurements of dilution occurring after the first 800 ft. of travel were not amenable to mathematical analysis. Upstream movement of sewage appears possible under certain conditions of wind, when sewage density is less than that of river water, and under certain conditions of river-bed topography, when sewage is heavier. It is probable that sewage will thus be borne upstream only when river velocity is very slow, and that an increase in velocity will tend to flush the errant material downstream. Samples of river-bottom sediment were taken for a period of several weeks after the test, and were measured for beta-gamma activity. The results of these measurements were analyzed in an attempt to define river-bed take-up of isotope by adsorption. Results appear to indicate that, where the sewage followed a path of well-defined width, adsorbed activity was 1.08 millicuries per square foot of river bottom. It must be recognized that this figure will likely vary with nature of bed material, nature of isotope, nature of isotope-laden medium, and river discharge.

A study of the data pertaining to passage downstream of the isotope indicates that the rate of take-up varied with time rather than with river discharge. This brings up the interesting implication that the take-up may be connected with the biologic regimen of the river rather than the hydrologic regimen. Quantitative studies of radioactivity of river water and stream bed indicate that a portion of the isotope was unaccounted for. A review of the several possibilities as to the fate of the "lost" radioactivity brings up many questions, such as proportion of take-up by suspended solids and by aquatic life. --Auth.

1-2579. Evenson, R. E. GEOLOGY AND GROUND-WATER FEATURES OF THE EUREKA AREA, HUMBOLDT COUNTY, CALIFORNIA: U.S. Geol. Survey, Water-Supply Paper 1470, 80 p., 15 figs., 2 pls. (in pocket), 11 tables, June 1959, 15 refs.

The principal ground-water basins in the area are the coastal plain of the Eel River valley and the Arcota plain, which is about 5 mi. wide and lies between the Mad River and the N. end of Humboldt Bay. The principal streams are the Eel River and the Mad River.

Unconsolidated clay, silt, sand and gravel - 3,000 to 4,000 ft. in thickness - make up the dune sand, alluvium, terrace deposits, and Hookton and Carlotta formations of Ogle. These deposits range in age from Pliocene to Recent, and contain most of the ground water.

Periodic water-level measurements indicated an average decline of about 5 ft. in water level in each basin during the irrigation season of 1952. These seasonal declines were balanced by recoveries of water levels during the next winter.

Most irrigating is done with ground water and is distributed principally through various types of sprinkler systems. About 250 irrigation wells supply water to nearly 12,000 acres. The total ground-water discharge, both natural and pumped, from alluvial deposits in 1952 was about 25,000 acre-ft.

The estimated gross ground-water storage capacity is about 150,000 acre-ft. The average seasonal net change in storage during 1951-1955 was about 25,000 acre-ft.

The quality of the water generally is good, most of it being a moderately hard calcium-magnesium bicarbonate water. Undesirable concentrations of Fe are found in many wells. Aquifers near tidal reaches of rivers may contain chloride concentrations of 500 to 2,000 p.p.m. --Auth.

1-2580. Kunkel, Fred, and F.S. Riley, GEOLOGIC RECONNAISSANCE AND TEST-WELL DRILLING, CAMP IRWIN, CALIFORNIA: U.S. Geol. Survey, Water-Supply Paper 1460-F, 39 p., 2 maps (1 in pocket, scale 1:62,500), May 1959.

The area of this study covers 5 alluvial-filled structural basins herein called the Camp Irwin, Bicycle, Langford, Coyote, and Dry Gulch basins. These basins lie NE. of the town of Barstow within or near the Camp Irwin Military Reservation.

The geologic units are grouped in 2 categories: consolidated rocks and unconsolidated deposits. The consolidated rocks are mostly hard and impervious, and, except for minor amounts in cracks and fractures, they are generally not water bearing. The unconsolidated deposits are porous and generally more permeable, and as a group are potentially capable of storing, transmitting, and yielding significant quantities of ground water.

The consolidated rocks, as mapped, include the crystalline basement complex of pre-Tertiary age, a series of volcanic and associated continental sedimentary rocks of Tertiary age, and 2 groups of volcanic rocks of later Tertiary to early Quaternary age.

The unconsolidated deposits, as mapped, comprise 6 units of alluvial deposits ranging in age from late Tertiary to Recent, as follows: granitic gravel of unknown origin, older fan deposits, older valley-floor alluvium, alluvial-fan deposits, valley-floor alluvium, and wash deposits. There are also 2 units of lake deposits, ranging in age from late Pleistocene to Recent, as follows: lacustrine and playa deposits, and dune sand of Recent age.

Four test wells were drilled in connection with this study. The logs of materials penetrated, the summaries of test pumping, and the chemical analyses of the waters are included; also given are similar data for 7 wells drilled by the U. S. Army from 1941 to 1944.

The geologic reconnaissance and well data indicate that the valley-floor areas of Camp Irwin, Bicycle, Langford, and Coyote basins are favorable for the development of ground water. Wells in these 4 basins yield from 115 to 1,700 g.p.m. One well in Dry Gul basin that was drilled to a depth of 335 ft. bottomed in basalt above the water table. --Auth.

1-2581. Poland, Joseph F., A.A. Garrett, and Allen Sinnott. GEOLOGY, HYDROLOGY, AND CHEMICAL CHARACTER OF GROUND WATERS IN THE TORRANCE-SANTA MONICA AREA, CALIFORNIA: U.S. Geol. Survey, Water-Supply Paper 1461, 425 p 34 figs. incl. maps, graphs, 20 pls. (under separat cover), 31 tables, May 1959, 85 refs.

The coastal plain in Los Angeles County, souther California, is divided into 2 distinct ground-water basins by the Newport-Inglewood uplift. On the NE., or inland side is the main coastal basin; on the SW., bordering the Pacific Ocean and extending from Long Beach to Santa Monica, is the so-called W. basin. The Torrance-Santa Monica area, as identified here embraces the western part of the coastal plain and spans the entire W. basin.

The W. basin, which includes about 180 sq. mi., is an area of expanding population and of rapid industrial growth. Its water supply for domestic, industrial, and irrigation uses is obtained chiefly fron wells. In the part of the W. basin S. of the Ballona escarpment - the Torrance-Inglewood subarea of this report - the draft on ground water has been excessive for many years, and local water levels, which were drawn down to about sea level by 1930, now are as much as 70 ft. below sea level. Saline contamination has developed extensively along the coast, and the ground-water supply is threatened with ultimate deterioration if the present draft is maintained.

This investigation, which covers the period from 1943 to 1947, was for the purpose of appraising the geologic conditions controlling the occurrence and circulation of ground water, the replenishment to the W. basin, and the extent and sources of saline contamination and methods for its control.

The dominant geologic formations of the area are of Tertiary and Quaternary age. The Tertiary rock of Miocene and Pliocene age, are formed almost entirely of marine deposits and consist chiefly of shale siltstone, and sandstone. Except in their uppermos part, they contain connate saline waters. The lowe part of upper division of the Pico formation (the youngest rocks of Pliocene age) has several relatively permeable sand members which collectively average at least 200 ft. in thickness. These sand members have not been tapped by water wells; however, they contain essentially fresh water and constitute a reserve supply. It would be expensive to develop this supply because the wells would have to be at least 1,500 ft. deep and would require special construction to hold back the sand.

The Quaternary rocks chiefly of Pleistocene age, contain almost all of the aquifers now tapped by wat wells. Deposits of Recent age in the W. basin occu only within the Dominguez and Ballona gaps. The Pleistocene deposits, which underlie most of the To rance-Santa Monica area, comprise 3 units which, downward succession, are: 1) a capping terrace deposit and the Palos Verdes sand, which is composed of sand, silt, and gravel, commonly not more than 30 ft. thick and, for the most part, above the water table; 2) the unnamed upper Pleistocene deposits co sisting of silt, clay, sand, and gravel, which are a much as 400 ft. thick and are of fluvial and marine origin; and 3) the San Pedro formation (composed of about half sand and gravel and half silt and clay) which is as much as 1,000 ft. thick and mostly of marine origin within the W. basin. The Silverado water-bearing zone and correlative aquifers in the San Pedro formation yield about 90% of the ground water pumped from the W. basin. The thickness of this principal aquifer ranges from 50 to 700 ft.; its extent within the W. basin is about 120 sq. mi. From pumping tests its permeability has been determined as ranging from 1,000 to 2,000 gallons per day per square foot (g. p. d. per sq. ft.).

The deposits of Recent age are the latest contributions to the alluvial fans of the Los Angeles and San Gabriel rivers. They underlie the Downey plain and extend across the W. basin as 2 tongues in Dominguez and Ballona gaps. The upper division is fine sand and silt, but the lower division is highly permeable coarse sand and gravel, as much as 75 ft. thick in Dominguez gap.

The Newport-Inglewood uplift - a regional anticlinal fold - is ruptured by a series of faults, which form a discontinuous but substantial barrier to underflow from the main coastal basin to the W. basin. These faults cut all rocks except those of Recent age.

Three distinct bodies of ground water occur in the area. In downward succession these are: 1) a body of shallow unconfined and semiperched water of inferior quality under natural conditions, which extends to a few tens of feet below the land surface; 2) the principal body of fresh ground water, which occupies almost all the deposits of Recent and Pleistocene age and the upper part of the underlying Pliocene rocks (extending to depths as much as 2,500 ft. below land surface in the W. basin and 8,000 ft. in the main coastal basin), which contains water of good quality; and 3) a body of saline connate water underlying the principal fresh-water body.

The principal body of fresh ground water underlies most of the Torrance-Santa Monica area and occurs beneath the greater part of the W. basin. Except near Redondo Beach and north of El Segundo, where a water table exists, the aquifers of the principal water body are confined and separated from each other by substantial thicknesses of relatively impermeable silt or clay.

In the Torrance-Inglewood subarea (the part of the W. basin S. of the Ballona escarpment), withdrawals of ground water increased from nearly 10,000 acre-ft. in 1904 to about 48,000 acre-ft. per year in the thirties, and then rose to about 78,000 acre-ft. in 1945, because of accelerated demands in the war years. In 1945 about half the withdrawal was used for industrial purposes.

As a result of this increase in draft, water levels noticeably declined in the early twenties and were drawn down to or below sea level throughout the subarea by 1930. A slow, irregular decline continued through 1941, when the decline was accelerated by the increased water demands of the war years. In 1946, local pressure levels in the Silverado water-bearing zone were as much as 70 ft. below sea level near the inland boundary of the basin. Because of the impermeable confining beds and disproportionate draft, water levels in the several aquifers have been drawn down unequally. For example, in the Gardena area in 1946, the pressure level in the Silverado water-bearing zone was 50 ft. below the semiperched water table, 20 ft. below the pressure level of the "200-ft. sand" and about 9 ft. below that of the "400-ft. gravel."

Under the early conditions of ground-water development, replenishment to the W. basin occurred 1) by underflow across the Newport-Inglewood uplift, 2) by direct infiltration of rainfall and return water from irrigation on the land surface, 3) by infiltration of local runoff, and 4) by seepage from the channel of the Los Angeles River to the S. and from Ballona Creek and its tributaries to the N. With the drawdown in water levels to and below sea level, water has been added to the basin in substantial quantity by landward encroachment of saline waters from the ocean and from the subsea extensions of the aquifers. Water also has been withdrawn from storage in the water-table reaches by compaction of the water-bearing system in the confined reaches.

The replenishment to the Torrance-Inglewood subarea under native conditions is estimated to have been within the range of 30,000 to 40,000 acre-ft. per year. From 1933 to 1941 the draft-averaged 48,000 acre-ft. per year. It is estimated that about 2,000 acre-ft. per year was withdrawn from storage, about 12,000 acre-ft. per year was contributed from the subsea extension of the aquifers or from the ocean, and nearly 34,000 acre-ft. per year was contributed by net fresh-water replenishment from all sources.

The underflow across the Newport-Inglewood uplift varies with the differential in pressure head across the barrier faults. For the reach from the Baldwin Hills to Long Beach, the average differential is estimated to have decreased from about 40 ft. in 1904 to 28 ft. in 1941 and to have increased to about 36 ft. in 1945 with the accelerated drawdown in the W. basin. The underflow into the Torrance-Inglewood subarea in 1945 is estimated as from approximately 15,000 to 20,000 acre-ft., or about 85% as much as the underflow during 1904. By 1945 the underflow is believed to have constituted nearly one-half the freshwater replenishment, and the probable excess of draft over net replenishment was at least 40,000 acre-ft. in that year. A major part of this excess draft was replaced by invasion of ocean water.

In the W. basin the native waters of good quality in the principal water body range in character from calcium bicarbonate to sodium bicarbonate, and their chloride content ranges from 25 to 90 p. p. m. For native inferior waters - those in which dissolved solids are in excess of 600 p. p. m. - the chloride content is as great as 500 p. p. m.

The potential contaminants of the ground water in the W. basin are ocean water, oil-field brines, and industrial wastes. The ocean water contains dissolved solids of about 34,000 p. p. m. and chloride content of about 19,000 p. p. m. The oil-field brines are connate waters from the Tertiary rocks and range in dissolved solids from about 10,000 to 39,000 p. p. m. The ocean waters are in contact with the subsea extensions of the aquifers; the oil-field and industrial wates have been discharged at the land surface and in stream channels.

In the twenties and early thirties, in response to the drawdown of the water level in the W. basin, certain wells tapping the principal water body along the W. coast between Santa Monica and Redondo Beach began to yield saline water. Contamination also developed near the Baldwin Hills and in Dominguez Gap about that time.

In general, the contaminated waters are not simple mixtures of the contaminant and native waters but have been so greatly modified that the nature of the contaminant is very obscure. Such modification is caused chiefly by base exchange - substitution of Ca and Mg for Na - and by sulfate reduction.

In the coastal part of Ballona Gap, contamination started in the twenties and by 1931 extended beneath nearly 5,100 acres; by 1946 this contamination extended to about 7,300 acres. Inland for about 1.6 mi. (near Lincoln Boulevard) the contaminated waters contain more than 500 p. p. m. of chloride. The contaminant at this point is almost wholly ocean water. Contaminated waters extend about 3 mi. inland in the Ballona Gap, and range in chloride content from 100 to 500 p. p. m. The source of the contaminant is not definitely known, but the high sulfate content indicates that the shallow unconfined waters are a principal source. Adjacent to the W. and N. flanks of the Baldwin Hills, oil-field wastes have contaminated 2 areas. The contamination on the W. flank is increasing but on the N. flank it has receded since the thirties.

Along the 11-mi. coastal reach, from the Ballona escarpment (Playa del Rey) to the Palos Verdes Hills, salt water has invaded the main water-bearing zones. Contamination was first noted at Hermosa Beach about 1915 and at El Segundo in 1921. By 1931 the coastal area underlain by contaminated waters amounted to almost 5, 000 acres, and the greatest inland extent was about 1. 3 mi. at El Segundo. By 1946 the contaminated area had increased by about 1, 700 acres. In the last 14 years the greatest advance of the front was between El Segundo and Manhattan Beach and was as much as 0. 5 mi. In the reach from the Palos Verdes Hills to Hermosa Beach the average rate of advance of the front was about 90 ft. per year from 1931 to 1941, and it had increased to about 140 ft. per year by 1946. From Hermosa Beach to El Segundo the average rate of advance in the thirties was about 115 ft. a year, but it was as much as 300 to 400 ft. per year by 1946. The chief source of contamination along the W. coast is ocean water. Near El Segundo, part of the early contamination seems to have developed from locally discharged high-sulfate waters.

In Dominguez Gap the Gaspur water-bearing zone, of Recent age, is extensively contaminated in 2 principal areas. Along the coast and inland, as far as the Pacific Coast Highway (State St.), this zone is highly contaminated with ocean water. Inland from this highway to Carson St. , about 3 mi. , the Gaspur zone is contaminated by waste brines from the Long Beach oil field. The Silverado water-bearing zone, which underlies the Gaspur zone but is separated from it by relatively impervious deposits several hundred feet thick, is uncontaminated as of 1947; however, it can become contaminated by downward movement of saline water through abandoned wells unless these wells are properly sealed. The contamination in the Gaspur water-bearing zone is not moving inland; it is moving slowly westward into the upper Pleistocene deposits, and ultimately will reach the Silverado water-bearing zone if the present water-level differentials of as much as 70 ft. are maintained.

The continued inland advance of ocean water into the W. basin, especially from the W. coast, would result in ultimate destruction of the supply of fresh water. The water rights in the Torrance-Inglewood subarea now are being adjudicated because it is recognized that the water supply is being excessively depleted and is being replaced by salt water. In most ground-water basins bordering on the ocean, the most effective long-term program for restraining or driving back saline waters depends upon raising water levels throughout the basin to such a height that fresh-water levels at the saline front will displace salt water seaward. Such raising of water levels ordinarily does not affect replenishment procedures.

However, in the Torrance-Inglewood subarea almost half the current replenishment is derived by underflow across the barrier features. If the restraint of ocean water should be achieved by raising water levels above sea level throughout the basin, and if water levels inland should remain at sea level, underflow across the Newport-Inglewood barrier would cease and half of the replenishment would be lost. Therefore, it seems that the amount of the natural fresh-water yield from the basin will remain substantial only if the salt water can be restrained by local control near the coast, and water levels immediately coastward from the barrier can be held low enough to induce continued underflow across the barrier.

Only 3 physical possibilities seem capable of such local control of saline waters: 1) the construction of artificial subsurface dikes or cut-off walls; 2) the development, by pumping, of a water-level trough coastward from the saline front; 3) the maintenance of fresh-water head above sea level at and immediately inland from the saline front. Only the maintenance of fresh-water head is considered to be an economic possibility. The fresh-water head required along the west coast would range from 3 to 13 ft. above sea level. It could be attained only by artificial recharge through wells, trenches, or pits. --Auth.

1-2582. Poland, Joseph F. HYDROLOGY OF THE LONG BEACH-SANTA ANA AREA, CALIFORNIA, WITH SPECIAL REFERENCE TO THE WATERTIGHTNESS OF THE NEWPORT-INGLEWOOD STRUCTURAL ZONE: U.S. Geol. Survey, Water-Supply Paper 1471, 257 p., 9 figs., 11 pls. (in pocket), 29 tables, July 1959, 36 refs.

This is the last of 3 reports describing ground-water features in the Long Beach-Santa Ana area and examines the hydrology with special reference to the watertightness of the Newport-Inglewood structural zone. The first section of this report presents results from an inventory of withdrawal of ground water in the Long Beach-Santa Ana area, 1932-1941, and in part through 1944. It describes the methods used in evaluating withdrawal, presents the yearly withdrawal by each city with a municipal water-supply system, and summarizes the estimated yearly withdrawal in each county by cities with municipally-owned systems and by private agencies for industrial, agricultural, and domestic uses. The area of inventory embraces all the coastal plain E. of Vermont Ave. , including the relatively small La Habra basin. The next section of this report describes the principal water-bearing zones from which the ground water is withdrawn.

Mendenhall in 1903-1904 made the only comprehensive previous estimate of ground-water withdrawal within the area, at which time about 160, 000 acre-ft. a year was used from flowing and pumped wells. Other estimates by several different agencies, made in the late twenties and in the thirties, are summarized in this report. However, each of these covered only a part of the subject area and was concerned more with over-all use than with ground-water draft.

In the evaluation of ground-water withdrawal, records were collected directly from the 9 cities in Los Angeles County and the 9 cities in Orange County that operate municipal water systems; these records are tabulated by years through 1944. Withdrawal by industrial plants was estimated through a brief but reasonably comprehensive field canvass, that embraced about 80% of such withdrawal in Los Angeles County and 90% in Orange County. Withdrawal for irrigation, which comprises about half the total in Los Angeles County and more than 80% of the total in Orange County, was evaluated by deriving yearly mean energy factors (energy expended in raising a unit quantity of water) and applying these factors to the quantity of electrical energy expended in pumping from wells. Adjustments were made for an estimated 10% of irrigation water raised by nonelectric pumps.

From 1932 through 1941 the yearly withdrawal of ground water from the part of the area in Los Angeles County ranged from 164,000 to 197,000 acre-ft. and the average was about 182,000 acre-ft.; from the part of the area in Orange County the yearly withdrawal ranged from 114,000 to 181,000 and the average was about 142,000 acre-ft. For the entire area the average was about 324,000 acre-ft. a year.

Within the Long Beach-Santa Ana area, the aquifers that yield ground water are tapped by 6,000 to 8,000 active or potentially active water wells of substantial capacity. Their depths range from 6 to 1,755 ft. In the coastal zone 32% of the wells range from 100 to 199 ft. deep and only 3% (50 wells) are more than 1,000 ft. deep. The wells of largest capacity commonly tap one or more of a few principal water-bearing zones. In Los Angeles County the wells of largest capacity occur 1) in and near Whittier Narrows, where many of the wells yield more than 1,000 g.p.m. (gallons per minute) and a few yield more than 3,000 g.p.m.; and 2) in the Long Beach district, where almost all the deeper wells yield more than 1,000 g.p.m. and 2 wells yielded 4,000 g.p.m. or more on initial test. Most of the productive wells in the Long Beach district tap the Silverado water-bearing zone of Pleistocene age. In Orange County the wells of largest capacity occur 1) in and near Santa Ana Canyon, where most wells yield more than 1,000 g.p.m. and a very few yield more than 3,000 g.p.m.; and 2) locally on and near the N. end of Newport Mesa, where several of the deeper wells yield more than 2,000 g.p.m. In the remainder of the project area, yields commonly range from 300 to 1,000 g.p.m.

With respect to principal water-bearing zones, this report summarizes their depth below land surface and thickness from place to place, the districts where each is tapped by wells, their relative water-yielding capacities, their estimated over-all yield, and the uses to which the water is put.

The 2 principal aquifers in the alluvial deposits of Recent age are the Gaspur and Talbert water-bearing zones. The Gaspur zone extends inland 21 mi. from Terminal Island to the Whittier Narrows, ranges in width from 1 to 4 mi. and ranges in thickness from 40 to 80 ft.; its top is from 50 to 100 ft. below land surface. It is tapped by wells throughout its full reach and the estimated withdrawal as of 1941 was about 25,000 acre-ft. a year. The Talbert zone extends inland 20 mi. from the Pacific Ocean to the Santa Ana Canyon, ranges in width from 1.2 to 6 mi., and ranges in thickness from 40 to 110 ft.; its top is from 50 to 90 ft. below land surface. It is tapped by wells from the coast inland about to Anaheim; the estimated withdrawal as of the early forties was between 25,000 and 30,000 acre-ft. a year. The "80-ft. gravel" underlies Bolsa Gap, has an over-all extent of about 10 sq. mi. between Midway City and the coast, and yields an estimated 2,500 acre-ft. of water a year. This local aquifer is in hydraulic continuity with the Talbert zone.

In the coastal zone of Los Angeles County the water-bearing deposits of Pleistocene age include 1) minor zones at shallow depth, 2) the Silverado water-bearing zone in the central and lower parts of the San Pedro formation, and 3) the water-bearing zone in the basal Pleistocene deposits NE. of Signal Hill.

Although the minor water-bearing zones are thin and discontinuous, they are tapped by many water wells of small capacity, of which most yield lightly to plunger pumps but a few yield several hundred gallons a minute to turbine pumps.

The Silverado water-bearing zone of the Long Beach district is the most extensive and productive single aquifer in the project area. It is tapped by many wells of large capacity, chiefly for industrial and municipal supply. The total withdrawal from the Silverado zone within the area has been from 30,000 to 35,000 acre-ft. a year in the late thirties. In the war period from 1941 to 1945, industrial expansion in the vicinity of Long Beach and Wilmington increased the yearly draft from the Silverado zone by about 9,000 acre-ft.

The water-bearing zone in the basal Pleistocene deposits NE. of Signal Hill ranges from 250 to 500 ft. in thickness and, as tapped by 7 active wells, its top is from 725 to 1,361 ft. below land surface. During the early forties, nearly half the yearly withdrawal by the city of Long Beach - that is, about 10,000 acre-ft. - was from this zone.

In the inland area of Los Angeles County the deposits of Pleistocene age range from 1,200 to 3,000 ft. in thickness except along the S. flank of the inland hills where they thin to a featheredge. Water-bearing zones in these deposits are tapped by wells to depths as great as 1,755 ft. Most of these wells yield from 400 to 1,000 g.p.m. In 1941 the several zones supplied about 100,000 to 110,000 acre-ft. of water.

In the coastal zone of Orange County the water-bearing deposits of Pleistocene age include 1) dispersed zones between the San Gabriel River and Huntington Beach Mesa, 2) several zones beneath Huntington Beach Mesa, and 3) a single principal zone beneath Newport Mesa.

The dispersed water-bearing zones between the San Gabriel River and Huntington Beach Mesa occur in a wedge of deposits which are 500 to 900 ft. thick along the Newport-Inglewood uplift and from 1,100 to 1,700 ft. thick along the inland edge of the coastal zone. These deposits are tapped by many wells which in 1945 yielded about 10,000 acre-ft. a year, largely for argicultural use.

Beneath Huntington Beach Mesa the Pleistocene deposits contain 3 water-bearing zones. The 2 upper zones are each about 50 ft. thick and have become contaminated by salt water. The lowest zone, which is about 250 ft. thick, has been tapped by relatively few wells but presumably was uncontaminated as of 1945 and presumably affords a large reserve source of water.

The principal water-bearing zone of Newport Mesa underlies at least 16 sq. mi., is from 300 to 521 ft. thick, and is tapped by more than a score of wells. It dips northward beneath and beyond the mesa and its top is from 236 to as much as 1,065 ft. below land surface. Individual wells yield more than 2,000 g.p.m. and the over-all draft was somewhat more than 3,000 acre-ft. a year in 1945.

In the inland area of Orange County the water-bearing zones of Pleistocene age range from a featheredge to more than 3,000 ft. in thickness. They are tapped by several thousand wells which are from 150 to 1,300 ft. deep, which range in yield from a few hundred to 3,000 g.p.m., but for which the average yield is about 600 to 800 g.p.m. As of the early forties about 80,000 to 100,000 acre-ft. of water was withdrawn yearly from these deposits.

The distinct bodies of ground water of the area are 1) a body of semiperched water which occurs at shallow depth; 2) the principal body of fresh ground water which occurs in the coarser basal deposits of the Recent alluvium, in about all the deposits of Pleistocene age, and in the upper division of the Pico formation; and 3) a body of saline water which underlies the fresh-water body throughout the area.

The semiperched body is unconfined and almost everywhere is separated from the underlying fresh-water body by fairly impermeable layers of silt or clay. It is replenished chiefly by rainfall and irrigation return water, and to a minor extent by the streams. Beneath most of the Downey plain it is less than 15 ft. below land surface. Under initial conditions it was fed in part by upward circulation from the underlying water body, but from 1918 to 1945 the pressure levels of the deeper zones have been drawn down below the water table of the shallow body and it has become semiperched artificially.

In the several gaps, the depth to its top ranges from a few feet to 25 ft. and its annual fluctuation is from 1 to 4 ft. In most of the gaps it is not a true semiperched water body at the present time because, except locally in Dominguez and Santa Ana gaps, its top is below the pressure surface of the underlying confined water.

The semiperched body is of interest in this investigation because it is of poor quality near the coast and is a potential source of contamination, by movement either downward through wells or landward during long periods of depressed water level. Because its level in 1945 was generally below that of the underlying principal body in the several gaps, however, it cannot pass into that body extensively at present.

The principal water body of the Long Beach-Santa Ana area has been extensively utilized, beginning about in 1870 and reaching a maximum in 1936. In the latter year, about 374, 000 acre-ft. of water was withdrawn from the entire area. The decline in water levels which developed as a result of this increase in use has crystallized the need for appraising the watertightness of the structural zone and has furnished specific evidence that is of great aid in such an appraisal.

Hydrographs, water-level contour maps, and profiles are introduced to show the changes that have developed in response to that use and to variations in rainfall.

The longest records of water-level fluctuation are for wells near Anaheim, in the intake area of the Santa Ana River alluvial fan, and for the Bouton wells, in the pressure area near Long Beach. Both show a decline of several tens of feet from about 1895 into the early 1900's, a fluctuating but fairly uniform level into 1917, and a second decline of about 70 ft. into 1936. These periods of decline were concurrent with periods of subnormal rainfall. During the wet cycle from 1936 into 1944, water levels near Anaheim recovered about 17 ft. but those at the Bouton wells continued to decline, contrary to the general regional recovery in Los Angeles County.

In Los Angeles County, the fluctuations in water level are treated separately for the Gaspur water-bearing zone of Recent age and for the deposits of Pleistocene age. In general, changes in water level in the Gaspur zone and in the Pleistocene deposits have been of the same order. In the Gaspur zone the greatest changes have occurred in or near the intake area below Whittier Narrows; in the Pleistocene deposits, however, lowering of several tens of feet has developed in critical areas near the coast.

Because of local concentrated draft, markedly disparate levels have developed in 2 or more water-bearing zones NE. of Signal Hill, in the Huntington Park area, and in the part of Dominguez Gap within the W. basin. The disparate levels developed NE. of Signal Hill have resulted in substantial artificial recharge to the basal water-bearing zone of Pleistocene age; in the latter 2 areas they have developed grave danger of saline contamination from overlying zones of Recent age.

In Orange County the long-term change in water level is discussed separately for the Talbert water-bearing zone of Recent age and for the deposits of Pleistocene age. In general, changes in water level in the Talbert zone and in the Pleistocene deposits have been of the same order. By 1928 most wells had ceased to flow and in the autumn of 1936 water levels were below sea level beneath about 155 sq. mi. of the county. Recovery from 1936 to 1944 was sufficient to redevelop flowing wells locally proximate to the structural zone.

At the coastal end of Santa Ana Canyon near Olive, a ground-water barrier apparently occurs in the deposits of Pleistocene age and partly restrains movement to the intake area.

Owing to the anticipated recurrence of periods of low-water level such as the one culminating in 1936, which depressed levels below sea level beneath about 185 sq. mi. within the main coastal basin in the 2 counties, the watertightness of the structural zone is a critical issue. That watertightness has been appraised largely by comparing hydrographs for wells on opposite sides of the barrier features. Conclusions based on hydrologic data, supplemented by geologic and geochemical evidence, are as follows:

For the reach in Los Angeles County: In Dominguez Gap there is no barrier to movement through the Gaspur water-bearing zone of Recent age. In the underlying Silverado zone a substantial barrier has been developed but presumably it is not wholly watertight. Along the Signal Hill uplift the barrier features form a reasonably effective barrier to water movement but evidence suggests that they are not wholly watertight against differential heads of several tens of feet. In Alamitos Gap, no barrier exists within the deposits of Recent age which extend to about 90 ft. below land surface. However, the barrier across the underlying San Pedro formation is belived to be virtually watertight.

For the reach in Orange County: The barrier within the Pleistocene deposits beneath Landing Hill appears to have been watertight initially, but in the late thirties a leak developed under a differential head of not more than 15 ft., presumably less than the initial differential head. In Sunset Gap no barrier is believed to have been developed in the deposits of Recent age but presumably they are not more than 20 ft. thick and of low permeability. At least in the central part of Sunset Gap, near Hog Island, the barrier in the underlying Pleistocene deposits is almost watertight below a depth of about 145 ft., but between land surface and that depth sufficient leakage now occurs to sustain a fresh-water lens coastward from the barrier features.

Beneath Bolsa Chica Mesa, the barrier features appear to be wholly watertight within the differential pressures imposed to 1945. In Bolsa Gap, there is no barrier to movement of ground water in the deposits of Recent age which contain the thin but permeable "80-ft. gravel." In the subjacent San Pedro formation the barrier is inferred to be watertight within the range of historic pressure differentials.

Beneath Huntington Beach Mesa the faults of the structural zone have formed only a partial barrier to water movement. For the lower and main water-bearing zone, however, direct ingress of ocean water seemingly is prevented by a lithologic discontinuity.

In Santa Ana Gap the barrier faults do not transect the Talbert water-bearing zone, and so form no barrier to water movement in that zone.

Thus, for the full reach of the Newport-Inglewood structural zone from Dominguez Gap to Newport Mesa, although the barrier features in the deposits of Pleistocene age are substantially watertight along most of that reach, no barrier whatsoever has been developed in the deposits of Recent age flooring the several gaps.

Under native conditions of ground-water circulation across the coastal plain the hydraulic barrier to landward encroachment was absolute. With the increasing development of the ground-water supplies, recurrent decline has developed in 2 periods of subnormal rainfall and has lowered water level about to sea level along the inland flank of the structural zone. Because the barrier features of that zone are not watertight, substantial encroachment of saline water can be anticipated during the next dry cycle unless protective measures are taken.

Methods to protect the invaluable ground-water supplies must be two-fold in nature. First, long-term basin-wide balance of draft and replenishment must be attained or the saline encroachment cannot be restrained. Secondly, even if that balance is achieved, in dry periods local control doubtless will be necessary proximate to the barrier features. There appear to be only 3 possibilities for such local control: 1) the maintenance of fresh-water head above sea level inland from the saline front, either by regulated draft or by artificial replenishment or both; 2) dewatering coastward from the saline front; or 3) the construction of impervious subsurface dikes.

Conditions within the several critical reaches are discussed. Those in Santa Ana Gap are the most critical. In that gap, in particular, and along the structural zone in general, the maintenance of fresh-water head above sea level appears to be the most feasible method and the construction of subsurface dikes the least feasible. --Auth.

1-2583. Wilson, H.D., Jr. GROUND-WATER APPRAISAL OF THE SANTA YNEZ RIVER BASIN, SANTA BARBARA COUNTY, CALIFORNIA, 1945-52: U.S. Geol. Survey, Water-Supply Paper 1467, 119 p., 20 figs. incl. maps, graphs, 8 pls. (under separate cover), 9 tables, June 1959, 25 refs.

Investigations of the ground-water resources of the Santa Ynez River basin prior to 1945 revealed that water levels had fluctuated only a little. Estimates of perennial yield therefore were based on the assumption that the base rate of ground-water inflow apparently was at least equal to withdrawals. Commencing in 1945, however, ground-water levels throughout the valley began to decline in response to increasing rates of withdrawal and extended drought, providing an excellent opportunity to check changes in ground-water storage in relation to withdrawals and replenishment.

Reappraisal of the ground-water resources of the Santa Ynez basin for the drought years 1945-1951 shows that, for a period in which replenishment from rainfall and seepage loss was far below normal, storage changes were inconsistent with withdrawals. Additional replenishment, besides that estimated by previous investigators, was made possible through a lowering of the water table and the consequent steepening of gradients out of older deposits adjacent to the basin.

Accurate estimates of perennial yield must await the collection of additional basic data because little is known regarding the rechargeable storage capacity and permeability of all the deposits, the rate of replenishment of the older deposits, amount of return irrigation water, and deep penetration of rain. However, most of the elements of recharge, discharge, and storage change were estimated for the 7-year period 1945-1952, and for the Lompoc subarea these data were extrapolated to estimate the order of magnitude of the quantity of water that could be pumped perennially. --Auth.

1-2584. Rasmussen, William C., and Gordon E. Andreasen. HYDROLOGIC BUDGET OF THE BEAVERDAM CREEK BASIN, MARYLAND: U.S. Geol. Survey, Water-Supply Paper 1472, 106 p., 19 figs., 10 pls. (7 in pocket), 10 tables, May 1959, 76 refs.

A hydrologic budget is a statement accounting for the water gains and losses for selected periods in an area. Weekly measurements of precipitation, streamflow, surface-water storage, ground-water stage, and soil resistivity were made during a 2-year period, Apr. 1, 1950 to March 28, 1952, in the Beaverdam Creek basin, Wicomico County, Maryland. The hydrologic measurements are summarized in 2 budgets, a total budget and a ground-water budget, and in supporting tables and graphs.

The results of the investigation have some potentially significant applications because they describe a method for determining the annual replenishment of the water supply of a basin and the ways of water disposal under natural conditions. The information helps to determine the "safe" yield of water in diversion from natural to artifical discharge. The drainage basin of Beaverdam Creek was selected because it appeared to have fewer hydrologic variables than are generally found. However, the methods may prove applicable in many places under a variety of conditions.

The measurements are expressed in inches of water over the area of the basin. The equation of the hydrologic cycle is the budget balance:

$$P = R + ET + \Delta SW + \Delta SM + \Delta GW$$

where P is precipitation; R is runoff; ET is evapotranspiration; ΔSW is change in surface-water storage; ΔSM is change in soil moisture; and ΔGW is change in ground-water storage. In this report "change" is the final quantity minus the initial quantity and thus is synonymous with "increase." Further, $\Delta GW = \Delta H \cdot Yg$, in which ΔH is the change in ground-water stage and Yg is the gravity yield, or the specific yield of the sediments as measured during the short periods of declining ground-water levels characteristic of the area. The complex sum of the revised equation $P - R - \Delta SW - ET - \Delta SM$, which is equal to $\Delta H \cdot Yg$ has been named the "infiltration residual"; it is equivalent to ground-water recharge.

Two unmeasured, but not entirely unknown, quantities, evapotranspiration (ET) and gravity yield (Yg), are included in the equation. They are derived statistically by a method of convergent approximations, one of the contributions of this investigation.

On the basis of laboratory analysis, well-field tests, and general information on rates of drainage from saturated sediments, a gravity yield of 14% was assumed as a first approximation. The equation was then solved, by weeks, for evapotranspiration, ET. The evapotranspiration losses were plotted against the calendar week. Using the time of year as a control, a smooth curve was fitted to the evapotranspiration data, and modified values of ET were read from the curve. These were used to compute weekly values of the infiltration residual, which were plotted against ground-water stage. The slope of the line of best fit gave a closer approximation of gravity yield, Yg. The process was repeated. The approximations converged, so that a fourth and final approximation resulted in a close grouping of all the points along a line whose slope indicated a Yg of 11.0%, and a slightly asymmetric bell-shaped curve of total evapotranspiration by weeks was obtained that is considered representative of this area.

Check calculations of gravity yield were made during periods of low evapotranspiration and high infiltration, which substantiate the computed average of 11.0%.

Refinements in the method of deriving the ground-water budget were introduced to supplement the techniques developed by Meinzer and Stearns in the study of the Pomperaug River basin in Connecticut in 1913 and 1916. The hydrologic equation for the ground-water cycle may be written $Gr = D + \Delta H \cdot Yg + ETg$, in which Gr is ground-water recharge (infiltration); D is ground-water drainage; ΔH is the change in mean ground-water stage (final stage minus initial stage); Yg is gravity yield (taken as 11.0% in computations here); and ETg is ground-water evapotranspiration.

The ground-water recharge is derived from the hydrograph of mean water level of the 25 wells, plotted weekly. The ground-water decline during periods of no rain (no recharge) is called a recession curve, and has a characteristic shape. This curve is extrapolated during periods when water levels rise in response to rain, so that the difference between peak stage and extrapolated recession stage may be determined. This difference, multiplied by the gravity yield, is the ground-water recharge, Gr.

The ground-water drainage, D, is calculated from a base-flow rating curve obtained by plotting the average water level in the 25 wells against the base flow obtained from the stream hydrograph. From this curve a close approximation of true weekly base flow was obtained and plotted as ground-water runoff on the stream hydrograph. This method is a second contribution of this investigation to statistical hydrology.

The difference between the mean ground-water stage of any 2 periods, ΔH, multiplied by the gravity yield, Yg, gives the net change in ground-water storage. When the final stage is less than the initial stage the difference becomes $-\Delta H$. With these factors known, the ground-water equation was solved for ground-water evapotranspiration, ETg. Comparison of ETg and total evapotranspiration, ET, was thus possible, for individual periods and on an annual basis.

Abundant rainfall and high infiltration rates provide this portion of the Atlantic Coastal Plain with large quantities of ground water, which are discharged about equally by runoff and evapotranspiration. Recovery of water lost to nonbeneficial plants, or by unused streamflow, would permit large expansion of ground-water facilities such as wells, dug ponds, and collection galleries, for irrigation, industry, or municipal supply. --Auth.

1-2585. Hubbell, D.W. and D.Q. Matejka. INVESTIGATIONS OF SEDIMENT TRANSPORTATION, MIDDLE LOUP RIVER AT DUNNING, NEBRASKA: U.S. Geol. Survey, Water-Supply Paper 1476, 123 p., 38 figs., 13 pls. (in pocket), 9 tables, June 1959, 17 refs.

An investigation of fluvial sediments of the Middle Loup River at Dunning, Nebraska, was begun in 1946 and expanded in 1949 to provide information on sediment transportation. Construction of an artificial turbulence flume at which the total sediment discharge of the Middle Loup River at Dunning, Nebraska, could be measured with suspended-sediment sampling equipment was completed in 1949. Since that time, measurements have been made at the turbulence flume and at several selected sections in a reach upstream and downstream from the flume.

The Middle Loup River upstream from Dunning traverses the sandhills region of N.-central Nebraska and has a drainage area of approximately 1,760 sq. mi. The sandhills are underlain by the Ogallala formation of Tertiary age and are mantled by loess and dune sand. The topography is characterized by NW.-trending sand dunes, which are stabilized by grass cover. The valley floor upstream from Dunning is generally about half a mile wide, is about 80 ft. lower than the uplands, and is composed of sand that was mostly stream deposited. The channel is defined by low banks. Bank erosion is prevalent and is the source of most of the sediment load. The flow originates mostly from ground-water accretion and varies between about 200 and 600 c.f.s. (cubic feet per second). Measured suspended-sediment loads vary from about 200 to 2,000 tons per day, of which about 20% is finer than 0.062 mm. and 100% is finer than 0.50 mm. Total sediment discharges vary from about 500 to 3,500 tons per day, of which about 10% is finer than 0.062 mm., about 90% is finer than 0.50 mm., and about 98% is finer than 2.0 mm. The measured suspended-sediment discharge in the reach near Dunning averages about 1/2 of the total sediment discharge as measured at the turbulence flume.

This report contains information collected during the period Oct. 1, 1948, to Sept. 30, 1952. The information includes sediment discharges; particle-size analyses of total load, of measured suspended sediment, and of bed material; water discharges and other hydraulic data for the turbulence flume and the selected sections.

Sediment discharges have been computed with several different formulas, and insofar as possible, each computed load has been compared with data from the turbulence flume. Sediment discharges computed with the Einstein procedure did not agree well, in general, with comparable measured loads. However, a satisfactory representative cross section for the reach could not be determined with the cross sections that were selected for this investigation. If the computed cross section was narrower and deeper than a representative cross section for the reach, computed loads were high; and if the computed cross section was wider and shallower than a representative cross section for the reach, computed loads were low. Total sediment discharges computed with the modified Einstein procedure compared very well with the loads of individual size ranges and the measured total loads at the turbulence flume. Sediment discharges computed with the Straub equation averaged about twice the measured total sediment discharge at the turbulence flume. Bed-load discharges computed with the Kalinske equation were of about the right magnitude; however, high computed loads were assocated with low total loads, low unmeasured loads, and low concentrations of measured suspended sediment coarser than 0.125 mm. Bed-load discharges computed with the Schoklitsch equation seemed somewhat high; about 1/3 of the computed loads were slightly higher than comparable unmeasured loads. Although, in general, high computed discharges with the Schoklitsch equation were associated with high measured total loads, high unmeasured loads, and high concentrations of measured suspended sediment coarser than 0.125 mm., the trend was not consistent. Bed-load discharges computed with the Meyer-Peter and Müller equation varied progressively with changes in several hydraulic parameters, compared reasonably with total and unmeasured sediment discharges, and increased fairly consistently as the concentration of measured suspended sediment coarser than 0.125 mm. increased.

Size analyses indicated that bed material varies both laterally and vertically. Composites of at least 5 samples, but preferably more, seem to be necessary for an adequate determination of the bed-material size distribution. The size distribution for the top 1 in. or so of the bed is generally finer than that for the top 6 in. The bed-material size distribution determined from 6-in. core samples does not seem to vary with either water temperature or water discharge.

Values of $\underline{z}_1$, the measured exponent for the equation of the vertical distribution of suspended sediment, that are less than about 0.7 are generally larger than associated $\underline{z}$'s that are determined from the theoretical equation. Values of $\underline{z}_1$ varied inversely with about the 0.6 power of $\underline{k}$, the Von Karman coefficient for turbulent exchange, throughout a range for $\underline{k}$ of 0.4-4.00. Also, $\underline{z}_1$ can be expressed roughly as a power of $\underline{z}$; the power depends on which system of fall velocities is used. --Auth.

1-2586. Johnson, C.R. and C.F. Keech. GEOLOGY AND GROUND-WATER RESOURCES OF THE BIG BLUE RIVER BASIN ABOVE CRETE, NEBRASKA: U.S. Geol. Survey, Water-Supply Paper 1474, 94 p., 10 figs., 2 pls. (in pocket), 5 tables, 1959, 24 refs.

Most of the Big Blue River basin above Crete, Nebraska, is underlain by sand and gravel of Pleistocene age that normally yields large quantities of water to wells. Deposits of till underlie the eastern part of the area, and here ground-water supplies are not abundant.

Generally, the ground water is of the calcium bicarbonate type; however, some water in the western part of the area has appreciable amounts of sulfate. The high sulfate may be attributed to oxidation of iron sulfides in the Niobrara formation. Because of its low total salt content, low B content, and low percent Na, the ground water is suitable for irrigation. Although the water is hard and locally contains high concentrations of Fe, it generally is potable and suitable for domestic use.

The general movement of the ground water is eastward toward the main stem of the Big Blue River.

Principal sources of ground-water recharge are precipitation on the area and underflow from adjacent areas to the W. Streams in the area generally receive water from, rather than contribute water to, the ground-water reservoir. As of 1953, the natural discharge of ground water into streams was about 150,000 acre-ft. per year and was much more than the amount pumped from wells.

The major use made of ground water in the area is for irrigation. About 60,000 acres is irrigated annually. The annual withdrawal of ground water for irrigation is about 61,000 acre-ft.; for domestic and stock use, about 25,000 acre-ft.; and for municipal use, 8,000 acre-ft.

The number of irrigation wells increased from 14 in 1938 to 672 by June 30, 1953. During 1948, 140 irrigation wells were constructed, and the average rate of construction from 1944 through 1952 was 53 wells per year.

Use of ground water for irrigation is steadily increasing, but in most parts of the area the available supplies are more than sufficient for present withdrawals. The past average annual rate of increase in ground-water withdrawals, if distributed over the area, could continue for perhaps 25 or 30 years without serious depletion of the ground-water reservoir, but the base flow of streams in the area probably would be reduced considerably. Because of the interest in, and the rate of development of, the ground-water resources, systematic collection of more adequate hydrologic data should be undertaken, and detailed quantitative studies should be made so that the perennial yield of the aquifer can be determined before serious depletion of the ground-water supply occurs. --Auth.

1-2587. Keech, Charles F., and V.H. Dreeszen. GEOLOGY AND GROUND-WATER RESOURCES OF CLAY COUNTY, NEBRASKA: U.S. Geol. Survey, Water-Supply Paper 1468, 157 p., 17 figs., 4 pls. (in pocket), 12 tables, June 1959, 39 refs.

This report presents the results of a cooperative investigation of the ground-water resources of Clay County, Nebraska, by the U.S. Geological Survey, and the Conservation and Survey Division, University of Nebraska. The fieldwork of the investigation, which constitutes a part of a statewide program of ground-water studies in Nebraska, was done during the summer of 1954.

Clay County is about 24 mi. square and in 1950 had a population of 8,700. The general physiography of the county is that of an almost level southeastward-sloping depositional plain, the original surface of which has been slightly modified by stream erosion and wind action. The Little Blue River is the only perennial stream in the county. Ephemeral streams which flow only during and after heavy rains include the West Fork of the Big Blue River and School, Big Sandy, and Little Sandy creeks. The climate is subhumid, the normal annual precipitation being about 25 in. Agriculture is the principal industry in the county, and corn is the most important crop. More than 21,000 acres was irrigated from water pumped from 257 wells in 1954. Corn, alfalfa, and grain sorghums are the principal irrigated crops.

Clay County is in the southeastern part of the loess-plains region of Nebraska and is immediately W. of the glaciated region. Sand and gravel and associated silt and clay deposits of Quaternary (Pleistocene) and Tertiary age mantle the area. The thickest deposits of sand and gravel are 2 broad buried channels, one in the northern part and one in the southern part of the county. The Pleistocene sand and gravel yields water readily to wells and is the principal source of ground water in the county. The deposits of Tertiary age, which consist principally of partly consolidated fine-textured continental deposits, also are saturated and yield water to some wells.

The deposits of Quaternary and Tertiary age rest on an eroded, uneven bedrock surface of rocks of Cretaceous age. The Ogallala formation of Tertiary age overlies truncated northwestward-dipping strata of Cretaceous age - in ascending order, the Niobrara formation, Carlile shale, Greenhorn limestone, and Graneros shale. No wells or test wells are known to have been drilled into formations older than the Graneros shale. The rocks of Cretaceous age have little significance as potential sources for ground water in Clay County.

The water available to wells in the county is derived entirely from precipitation on the area or areas immediately W. and N. The conclusion is reached that recharge by infiltration of precipitation through the soil is considerable and probably averages about 1.5 in. per year.

The use of ground water for irrigation has increased greatly since 1952, and more ground water probably could be used without a serious lowering of the water table. A map showing the thickness of the water-bearing materials indicates that, although most of the county has enough underlying water-bearing material to support irrigation wells, parts of the county have little or none.

Studies of the quality of ground water show that the water has a relatively low mineral content and is of the calcium bicarbonate type; mineralization as measured by specific conductance, ranged from 317 to 691 micromhos (approximately 210 to 450 p.p.m. of dissolved solids). The quality is affected appreciably by local conditions in the proximity of each well, but countrywide water-quality patterns, which are related to water movement and recharge, geology, and hydraulics of water-bearing material, are apparent. The water is hard but, with the exception of some water having high concentrations of Fe, is usable for most domestic purposes. Irrigation water in some parts of the country contains sufficient Ca to maintain the present levels of crop productivity and soil tilth, but the addition of Ca to the soil may be helpful in other areas. Calculated leaching requirements were determined for each of the water samples taken during the investigation. --Auth.

1-2588. Powell, J.E. PROGRESS REPORT ON THE GEOLOGY AND GROUND-WATER RESOURCES OF THE WESTHOPE AREA, BOTTINEAU COUNTY, NORTH DAKOTA: North Dakota Geol. Survey, Ground-Water Studies no. 27, 68 p., 6 figs. incl. illus., 4 maps, secs., 4 tables, 1959, 16 refs.

The area described in this report is in Bottineau County in N.-central North Dakota and consists of approximately 81 sq. mi. in the vicinity of the city of Westhope. The geologic units in the area, from the land surface down, are as follows: alluvium of Recent age; glacial deposits of Pleistocene age, consisting of deposits of glacial Lake Souris, deposits in the valley of the Souris River, and till and associated meltwater deposits of sand and gravel; and bedrock consisting of the Cannonball (?) member of the Fort Union formation of Paleocene age, the Fox Hills (?) sandstone of Late Cretaceous age, and the Pierre shale of Late Cretaceous age. Older Cretaceous formations include the Niobrara formation, Benton shale equivalents, and the Dakota sandstone.

Glacial deposits in the area probably originated during the Wisconsin stage of the Pleistocene epoch. Thirty-nine test holes drilled completely through the glacial drift indicate a range in thickness of 86 to 195 ft. and an average of 140 ft.

Surface deposits in the area consist almost entirely of lake clay deposited by the waters of glacial Lake Souris. The glacial-lake deposits range in thickness from 12 ft. to 57 ft. and average 27 ft. A few wells in the area obtain water from a sandy and gravelly zone near the base of the lake deposits. Generally wells of this type are less than 30 ft. deep and supply only small amounts of water.

Older and more permeable alluvial deposits are found in the valley of the Souris River beneath the Recent alluvium and the deposits of glacial Lake Souris. These deposits are largely discontinuous, interbedded, and gradational, and consist of sand, gravel, and clay in varying proportions. The older alluvial deposits range in thickness from 12 ft. to 39 ft. and average 23 ft.

Glacial till is present throughout the report area. It underlies the deposits of glacial Lake Souris in the uplands and occurs immediately below the deposits of older alluvium in the Souris River valley. The till is composed of heterogeneous material ranging in size from clay to large boulders. The glacial till ranges in thickness from 36 ft. to 152 ft. and averages 113 ft.

Either the Cannonball (?) member of the Fort Union formation or the Fox Hills (?) sandstone, or both, are believed to be present below the glacial till at some locations in the Westhope area. Cuttings from test holes that penetrated these deposits consisted of smooth gray clay or grayish-green sandy clay. As no fossils were recovered, the deposits could not be positively identified.

The Pierre shale is the oldest formation penetrated by test drilling. In the report area it consists of medium-light to dark-gray clay and siltstone. Cuttings from most test holes contained fragments of bentonite and selenite (gypsum). The thickness of the Pierre shale in the Westhope area is believed to approximate 1,200 ft.

Ground water in sufficient quantity to supply a city or other large user is difficult to obtain in the Westhope area. Small amounts of water sufficient for individual farm and domestic use are obtained at the base of the deposits of Lake Souris and from aquifers in the glacial till.

Water of satisfactory quality to meet U.S. Public Health Service standards probably is not present in the report area. In most of the area the ground water has high concentrations of dissolved solids (more than 1,000 p.p.m.) and, except in a few places, is very hard. Chemical analyses of water from 6 wells in the area show that it is generally unsuitable for irrigation.

The deposits of older alluvium in the valley of the Souris River 2 mi. E. of Westhope may be sufficiently permeable to yield larger amounts of water. However, additional test drilling and aquifer tests would be necessary to determine whether the alluvial deposits are sufficiently permeable and widespread to yield substantial water supplies. --Auth.

1-2589. Ohio, Division of Water. WATER INVENTORY OF THE CUYAHOGA AND CHAGRIN RIVER BASINS, OHIO, by Sherman L. Frost and Robert C. Smith: Its: Ohio Water Plan Inventory, Rept. no. 2, 2 v.: v. 1, Basin Review, 20 pls. incl. illus., maps (3 fold.), graphs, 10 tables; v. 2, Map Supplement, 21 maps, 3 cross secs., tables, Jan. 1959, 44 refs.

This report is the first in a series of studies planned to cover each of 18 major river basins and 108 watershed areas within them, a complete coverage of the state. It makes extensive use of water resources data obtained through cooperative arrangements with the U.S. Geological Survey. Findings should prove useful to county and municipal leaders, engineers, planning organizations, chambers of commerce, industry, agricultural extension and soil conservation groups, water agencies, universities, schools, etc.

The text volume contains discussion of the area and its economy; surface- and ground-water supply, including watershed areas, precipitation and stream flow, possible reservoir sites, surface water developments, ground-water resources, quality of water, and pollution; water use; watershed management, including soil characteristics, floods, erosion and sediment action, soil conservation and drainage; future needs and development of water supplies. Maps, graphs, and tables in the text volume and map supplement facilitate interpretation of the data.--A. C. Sangree.

1-2590. Water Research Foundation for the Delaware River Basin. A BRIEF REPORT ON THE STUDY OF GOVERNMENTAL ORGANIZATION FOR THE WATER RESOURCES OF THE DELAWARE RIVER BASIN BY THE MAXWELL GRADUATE SCHOOL, SYRACUSE UNIVERSITY: 28 p., map, [Philadelphia?] 1959.

A 500-page study of governmental administration for the water resources of the Delaware River basin has been made at the Maxwell Graduate School of Public Administration of Syracuse University. This is a summary of that report including the following sections: functions of water resources administration; American experience in river basin organization; Map-Delaware River basin and service area; legal basis for water resources organization; financing water resources administration; structure for a Delaware River basin administration; and powers of a Delaware River basin administration.--M. Russell.

1-2591. Bagley, Jay M., Wayne D. Criddle, and R. Keith Higginson. WATER SUPPLIES AND THEIR USES IN IRON, WASHINGTON AND KANE COUNTIES OF UTAH: Utah, Agr. Expt. Sta., Spec. Rept. 13, 56 p., 7 maps (3 fold.), chart, 11 graphs, 41 tables, [1958?], 28 refs.

The results are reported of a study to ascertain and inventory the supplies and uses of water available to individual areas in Iron, Washington, and Kane counties. Most of the cultivated soils are naturally productive, as long as adequate moisture is available, so that irrigation farming is practiced on a large scale. Power, livestock, and industries are other major users of water. The report is a compilation of information and data on which to base plans for future water resources development. The following subjects are covered: climate and its relation to water use, precipitation, snow surveys, evaporation, and temperature; surface waters, their pattern, streamflow records, watershed yields, storage, transmountain diversions, and floods; underground water, particularly in Cedar City Valley, Parowan Valley, and Beryl-Enterprise district; water quality including salinity, silt, and sediment; water uses; power development; irrigation problems, and future use.--M. Russell.

12. MINERAL DEPOSITS

See also: Geologic Maps 1-2420, 1-2421, 1-2424, 1-2425; Structural Geology 1-2467; Geophysics 1-2516, 1-2517.

1-2592. Riley, Charles M. OUR MINERAL RESOURCES: AN ELEMENTARY TEXTBOOK IN ECONOMIC GEOLOGY: 338 p., 102 figs. incl. illus., maps, secs., diags., tables, New York, John Wiley & Sons; London, Chapman & Hall, 1959, refs.

This book discusses the occurrence, use, prospecting methods, and world production of metallic and nonmetallic resources in common use today. It is divided into 2 sections - 1) metallic minerals and 2) nonmetallic minerals. The first chapter deals with principles of ore deposition. Basic facts and definitions are given along with a discussion of ore deposits and a brief history of theories on ore formation. A classification and explanation of metallic ore deposits covers 6 types of deposits. The remaining 9 chapters in Section 1 cover: iron; aluminum; copper; lead and zinc; tin and tungsten; gold and silver; nickel, chromium, and platinum; uranium and vanadium; and miscellaneous metals - manganese, mercury, molybdenum, cobalt, titanium, antimony, magnesium, beryllium, bismuth, and cadmium.

The following topics are discussed in the 7 chapters in Section 2: nonmetallic minerals; ground water; coal; petroleum; rock and mineral building materials - building stone, crushed stone, rock for structural ceramic products, gypsum; minerals for chemical uses - salt, borax and borates, potash, nitrates, phosphates, sulfur; gems and gemstones - diamonds, ruby and sapphires, emeralds and other beryls, opal, quartz, synthetic gems; and miscellaneous nonmetallic minerals, - mica, asbestos, and barite.

Six appendices provide: glossary, list of chemical elements, geologic time scale, list of the ore minerals of various metals, list of valuable nonmetallic minerals, and general references. References are also given at the end of each chapter.--L. M. Dane.

1-2593. Stone, John G. ORE GENESIS IN THE NAICA DISTRICT, CHIHUAHUA, MEXICO: Econ. Geology, v. 54, no. 6, p. 1002-1034, 7 figs. incl. 3 maps, sec., diag., 2 tables, Sept.-Oct. 1959, 42 refs.

In the Naica mining district of N.-central Mexico, pyrometasomatic and mesothermal replacement bodies of base-metal sulfides with minor amounts of Ag and Au occur in a thick sequence of locally marmorized Cretaceous limestone. The only igneous rocks known in the Sierra de Naica, consisting of thin, discontinuous dikes and sills of very fine-grained quartz and feldspar, have themselves been altered and partly replaced during ore emplacement.

Ore emplacement in the district was controlled by dikes and sills, and steeply dipping NW. and NE. fractures. Movement took place on faults belonging to both of these fracture sets before, during, and after the period of mineralization. Two structural types of ore body are exposed - gently dipping silicate-sulfide sheets or "mantos," and steeply plunging chimneys of sulfide ore with or without minor amounts of silicates, localized along steep NE. or NW. faults. The main manto consists of a central zone with wollastonite, grossularite, and vesuvianite (idocrase), minor scheelite. This zone grades laterally into ore containing manganhedenbergite, quartz, and calcite, that was deposited in cooler ground adjacent to the central conduit. The fluids that deposited these marginal zones were depleted in Al, W, and Ag, and relatively enriched in Fe by the deposition of silicates and sulfides in the central zone of the ore body.

The silicates and sulfides were introduced into the manto by a single fluid that did not change in composition during the course of formation of this ore body. Silicates were deposited first, followed by sulfides that crystallized at temperatures on the order of 500°-550°C. The mantos were cut by silicate-bearing chimneys of sulfide ore that were in turn succeeded by mesothermal massive sulfide ore during the last stages of mineralization in the district. Most of the mesothermal ore appears to have been deposited at the same temperature and pressure as the earlier pyrometasomatic ore, suggesting that in this instance, the difference between the 2 types of ore is due to progressive changes with time in the composition of the ore-forming fluid, rather than to changes in the physical conditions of deposition. The silica, Al, Mg, W, and Ag content of the fluid decreased relative to the content of Pb, Zn, Fe, and S. In addition, the amount of Fe carried by the fluid increased markedly with respect to Pb and Zn during the course of mineralization in the district. While the oxidation state of the fluid as a whole remained nearly constant with time, it did change, due solely to the drop in temperature, during the course of crystallization within each successive ore body. The inferred changes in the mineralizing fluid with time are virtually identical to the changes in the mantos produced by the progressive reaction of the fluid with limestone. --Auth.

1-2594. Koch, George S., Jr. LODE GOLD MINES OF THE CENTRAL PART OF THE GRANITE MINING DISTRICT, GRANT COUNTY, OREGON: Oregon, Dept. Geology & Mineral Industries, Bull. no. 49, 49 p., 25 figs. incl. maps (4 in pocket), 1959, 24 refs.

The Granite mining district of easternmost Grant County, Oregon, has produced about $1, 800, 000 in Au and Ag from lode mines since its discovery in 1861. Mines and prospects described are the Buffalo, Cougar-Independence, Ajax, Magnolia, Continental, New York, Blue Ribbon, Standard, and Tillicum.

All of the ore is in fissure veins that cut argillite of probable Permian age and granodiorite of probable Cretaceous age. The veins contain the minerals pyrite, arsenopyrite, chalcopyrite, galena, sphalerite, tetrahedrite, native Au, quartz, and calcite. Adjacent to the veins the wall rocks have been altered by hydrothermal solutions as described in a 9 p. appendix by S. H. Pilcher. Rocks later than the veins and their country rocks comprise younger basic lavas and Quaternary alluvium.

At the Buffalo mine, which is the only property that has produced ore since World War II, monthly output in 1957 was between 150 and 200 tons of ore with a gross value of about $53. per ton produced with operating costs of about $33. per ton. --Auth.

1-2595. Smith, Laurence L. THE LANDRUM MINE, EDGEFIELD COUNTY, SOUTH CAROLINA: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 3, no. 3, p. 1-10, 2 maps (1 fold.), May-June 1959, ref.

The Landrum mine and adjacent Quattlebaum mine are in sericitic phyllite of the Carolina slate group in northern Edgefield County, South Carolina. Finely divided Au occurs with pyrite in quartz veins and stringers, and to some extent is disseminated in the immediately adjacent country rock. The mineralized body is tabular, strikes about N. 60° E., and dips nearly vertically. In the zone of weathering most of the Au is free. In fresh rock the Au is largely bound up in the sulfides. Results of 38 assays indicate the average tenor of the ore is between $5. and $6. per ton. About 2, 000, 000 tons of mineralized rock are inferred to a depth of 300 ft. --H. S. Johnson, Jr.

1-2596. Ekiert, F., and E. Konstantynowicz. NON-FERROUS ORE DEPOSITS IN BULGARIA. Prepared by the United States Joint Publication Research Service: Internat. Geology Rev., v. 1, no. 8, p. 67-72, map, 4 secs., Aug. 1959.

Cu, Pb, Zn, and Fe are the major mineral resources of Bulgaria. Bornite, as well as tetrahedrite, chalcopyrite, pyrite, and colomorphic sphalerite, occur in Triassic dolomite limestones of the Plakalnica deposit. Porphyry Cu deposits occur in Laramide quartz monzonite, granodiorite, and quartz diorite intrusions at Miediet. Other areas of Cu mineralization are associated with relatively young volcanic activity and extensive hydrothermal alteration. The Zn and Pb deposits are Bulgaria's principal mineral wealth. These occur in the Siedmoichislenie deposit as individually zoned minerals in Triassic dolomitic limestones and as metasomatic replacements probably related to Oligocene rhyolites in the Hercynian-faulted Rhodope massif. Seventy percent of the Fe of the Kremikovtsi deposits resulted from the oxidation of siderite to limonite in deformed Triassic sediments. --G. E. Denegar.

1-2597. Dennis, John G. NOTE ON SOME CASSITERITE-BEARING PEGMATITES NEAR BRANDBERG, SOUTH WEST AFRICA: Econ. Geology, v. 54, no. 6, p. 1115-1121, 4 figs. incl. 2 maps, secs., Sept.-Oct. 1959, 7 refs.

N. of the Brandberg, South West Africa, cassiterite-bearing pegmatites are emplaced in Precambrian lower Damara schists. Most of the pegmatites are in steeply NW. -dipping fractures parallel to layering in 2 small granite bodies associated with the pegmatites. Certain criteria suggest replacement origin for the pegmatites. Sn mineralization is in scattered greisenized zones and in quartz zones and veins. --Auth.

1-2598. Drubina-Szabo, Magdalene. MANGANESE DEPOSITS OF HUNGARY: Econ. Geology, v. 54, no. 6, p. 1078-1094, 5 figs. incl. illus., 2 maps, secs., graphs, Sept.-Oct. 1959, 41 refs.

With the exception of one small occurrence, the Mn deposits of Hungary are of sedimentary origin. The 2 most important occurrences are at Urkut and Eplény, both in the Bakony mountains of western Hungary. The primary ore in these deposits is of late Liassic age. Two types of ore are recognized - manganese oxides and manganese carbonate.

The primary ore is associated with a typically Alpine facies of Jurassic age. It occurs in a block faulted region, where, in a few places, local folding is also present. As a result of emergence at the end of Jurassic time, the Urkut deposit was exposed to erosion, and the primary ore became oxidized and concentrated in a secondary deposit. At Eplény, secondary concentration took place during early Eocene time, also as a result of a long period of emergence and attendant erosion.

The primary manganese oxide ore occurs irregularly as concretions or layers in a variegated clay. The ore minerals are pyrolusite and psilomelane. Two types of primary carbonate ore are present: the "gray" ore contains only rhodochrosite, whereas the "brown" ore contains the rhodochrosite and also manganese hydroxide (vernadite), with goethite in considerable quantity. The host rock of this deposit is a Radiolaria-bearing marl. The secondary, oxidized ore is very clayey and contains detritic material with a low percentage of Mn.

The formation of the oxide and carbonate ores was controlled apparently by physico-chemical differences in the sedimentary basin; the oxide ore was formed in an oxidizing environment whereas the carbonate ore was formed in a reducing environment as a result of rhythmic chemical precipitation. The source of the Mn in these deposits was at a considerable distance and consisted probably of a moderately basic igneous or metamorphic complex, which underwent disintegration and leaching, the Mn being transported in solution into the collecting basin. --Auth.

1-2599. Warner, Lawrence A., William T. Holser, V.R. Wilmarth, and Eugene N. Cameron. THE OCCURRENCE OF NONPEGMATITE BERYLLIUM IN THE UNITED STATES: U.S. Geol. Survey, Prof. Paper 318, 198 p., 60 maps (5 in pocket), 3 secs., diag., graph, 82 tables, Aug. 1959, 466 refs.

The demand for Be in industry increased rapidly during and after World War II, establishing a trend that is likely to continue. Production of beryl from pegmatites, the only present source of Be, has lagged far behind annual consumption in the United States, and even with heavy imports, an adequate domestic supply has not been assured. This condition has directed attention to nonpegmatite deposits. During the period 1948-1950 the U. S. Geological Survey conducted a program of field, laboratory, and library research to determine the occurrence and distribution of Be in nonpegmatite rocks and mineral deposits, and to appraise the extent to which these might furnish Be ore. Although no deposits of present commercial value were found, the investigation has set criteria that will be of value in future prospecting.

The average beryllia content of the lithosphere is about 0.001%. Be is thus more abundant than certain other metals, such as As, Au, Ag, W, and Mo. Unlike these elements, however, Be does not readily form sulfides and oxygen salts, which constitute the bulk of metalliferous ores. Because of its small ionic radius, resulting low coordination number, and strongly electro-positive character, crystal structures that will permit high concentrations of Be in minerals are comparatively rare. It forms only a few stable minerals of its own, such as beryl, helvite, chrysoberyl, and phenakite. In other silicates, including the common rock minerals, it may replace elements such as Si and Al to a slight extent. Under special conditions, as when it fills normally empty lattice positions in idocrase, it may be present in appreciable quantity.

As an accessory constituent in rock minerals, Be is somewhat more common in granitic and feldspathoidal rocks than in other igneous rocks. Its principal occurrence is in beryl in granitic pegmatites. Other than in pegmatites, Be minerals are found chiefly in quartz-W veins and pyrometasomatic deposits. Small amounts also occur in other types of veins, particularly quartz-Au and Mn veins. In most of these occurrences Be is found with fluorite: in pyrometasomatic deposits it sometimes occurs with fluorine-rich beryllian idocrase.

Many sedimentary rocks contain small quantities of Be, particularly those formed by residual concentration, as the metal hydrolyzes in a manner similar to Al. For the most part, however, Be tends to be dissipated by processes of weathering and sedimentation. Under simple metamorphic conditions, Be is not easily mobilized, and therefore it is not concentrated in metamorphic rocks other than pyrometasomatic deposits.

Pyrometasomatic deposits and feldspathoidal rocks were sampled at many localities in the United States. Only a small proportion of the pyrometasomatic deposits contained detectable quantities of Be; the richest are the deposits at Iron Mountain, New Mexico. In the feldspathoidal rocks, Be was found only as an accessory constituent in rock minerals.

Some of the vein deposits investigated have promise as possible sources, but sampling was not sufficiently detailed to furnish a basis for calculating reserves. In places the Be content compares favorably with that of beryl pegmatites. Mining of these deposits will depend on an increase in price of Be, improved beneficiation methods, and utilization of coproducts and byproducts. --Auth.

1-2600. Walker, Frank H. NATURAL BRINES OF INDIANA AND ADJOINING PARTS OF ILLINOIS AND KENTUCKY: Indiana, Geol. Survey, Rept. Prog. 13, 58 p., 13 figs., 20 tables, 1959.

This preliminary report on the natural brines of Indiana and adjoining parts of Illinois and Kentucky is a compilation of 473 brine analyses. The analyses were obtained from the files of many companies as well as from published reports of the Indiana, Illinois, and Kentucky Geological Surveys. The analyses are classified on a stratigraphic basis and cover stratigraphic units that range from the Knox dolomite (Cambrian and Ordovician systems) to the Pennsylvanian system. The locations of wells or leases from which samples were obtained for 11 units of the Chester series and the Ste. Genevieve limestone (Mississippian system) are shown on maps. The total solids in parts per million of the brines sampled from these stratigraphic units also are shown on the maps.

A comprehensive brine-analysis program has been started by the Indiana Geological Survey. This program will result in a relatively detailed publication on Indiana brines. --Auth.

1-2601. Clabaugh, S.E., and V.E. Barnes. VERMICULITE IN CENTRAL TEXAS: Texas, Univ., Bur. Econ. Geology, Rept. Inv. no. 40, 32 p., 6 figs., Aug. 1959, 11 refs.

Vermiculite deposits in the central mineral region of Texas, chiefly in Precambrian metamorphic rocks, are situated in Llano County and adjacent parts of Mason, Gillespie, and Burnet counties with minor occurrences in Blanco and San Saba counties.

The bulk of the vermiculite is from weathering of biotite formed in the following suggested manner: 1) intrusion of sills and irregular masses of gabbro into the Valley Spring gneiss prior to or during regional metamorphism; 2) metamorphism of gabbro to produce amphibolite; and 3) partial conversion of amphibolite to biotite schist by metasomatism accompanying the emplacement of granites and pegmatites. In one deposit the process seems to have been arrested in the amphibolite stage with introduction of nonoriented biotite and feldspar by potash metasomatism.

A third distinct type of vermiculite deposit associated with serpentine and soapstone appears to be primarily hydrothermal rather than a weathering product of biotite. Suggested events leading to the formation of this type of deposit are: 1) emplacement of dunite and gabbro in Valley Spring gneiss; 2) metamorphism of gabbro to form amphibolite with deformation of dunite into lenticular masses; 3) alteration of dunite to nonfoliated serpentine during static conditions and through the influence of aqueous solutions; 4) alteration of serpentine to soapstone from periphery inward through influence of fluids from nearby granite intrusions; and 5) formation of vermiculite veins along fractures in soapstone and serpentine through the influence of fluids from pegmatites which closely followed the granite intrusion. --V. E. Barnes.

1-2602. Parham, Walter E. LIGHT-BURNING CLAY RESOURCES IN LASALLE COUNTY, ILLINOIS: Illinois State Geol. Survey, Circ. 277, 27 p., map, diag., column, 1959, 6 refs.

For this study of the nature and possible uses for the light-burning clay deposits of La Salle County, Illinois, about 50 samples of the underclay below the No. 2 Coal were collected and tested.

Laboratory tests were run to determine the drying and firing shrinkage, water of plasticity, fired color, refractoriness, and bonding properties of the clay. The thickness of the clay, its overburden, and types of associated sediments were recorded from field observations and, at some places, from water well driller's logs.

The most favorable areas for prospecting for light-burning clay are found along the tip of the river bluffs on the S. side of the Illinois River between the towns of La Salle and Ottawa, and in the valley flats E. of Ottawa along the N. side of the river. Most of the shallow light-burning clay deposits observed in outcrop have been exhausted or are now being quarried, but exploratory drilling may locate other deposits at depths shallow enough to be worked commerically. --Auth.

1-2603. Schwartz, George M., and others. INVESTIGATION OF THE COMMERCIAL POSSIBILITIES OF MARL IN MINNESOTA: 190 p., 94 figs., 38 tables, St. Paul, Minnesota, Office of the Commissioner of Iron Range Resources and Rehabilitation, 1959.

The report covers a wide range of subjects having a bearing on the composition, physical characteristics and possible uses of fresh-water marl. Agricultural needs and possible uses of lime for soils and food supplements for livestock are discussed; also requirements for use in portland cement. One chapter outlines a new, simple, rapid method of chemical analysis. Results of various experiments on drying marl are cited in detail. An appendix consists of a reprint of Part II of Minnesota Geological Survey Bulletin 23 which describes the origin and occurrence of marl in Minnesota and has brief county reports and maps. The general conclusion is that marl has few commercial possibilities at present other than for local use for acid soils. --Auth.

1-2604. McGregor, Duncan J. CEMENT RAW MATERIALS IN INDIANA: Indiana, Geol. Survey, Bull. 15, 88 p., 3 figs., 2 pls., 34 tables, 1958.

Limestone that is chemically suitable and easily accessible for cement manufacture can be found at many places in Indiana in the Mississippian limestones and to a more limited extent in the Devonian limestones. Clay, shale, and gypsum, also used in manufacturing cement, are readily available close to limestone reserves. Five areas in Indiana are most favorable for establishing cement plants: Bloomington-Spencer-Gosport, Paoli-Mitchell-Bedford, Greencastle, central Clark County, and southern Harrison County; a sixth area, E. of Logansport, also may have limestone suitable for cement manufacture. Five of these areas are close to railroad lines and fuel supplies; the southern Harrison County area is favorably situated for barge transportation on the Ohio River. Reserves of mineral raw materials in 5 of the areas probably are sufficient to supply a cement plant for 50 years. Surface study does not permit an accurate appraisal of the Logansport area, but it probably also has sufficient reserves. --Auth.

1-2605. Miller, E. Willard. MINERAL REGIONALISM OF THE CANADIAN SHIELD: Can. Geographer, no. 13, p. 17-30, 6 maps, 1959, 15 refs., abs. in English and French.

Exploitation of minerals on the Canadian Shield has progressed rapidly in the 20th century with mineral output expanding from less than $15, 000, 000 annually at the turn of the century to over $800, 000, 000 in 1956. For more than a half century areas dominated by a mineral economy have increased in number. Consequently there are some mineral regions on the Canadian Shield that are in an initial stage of exploitation while other areas are declining due to mineral exhaustion.

Mining regions change through time just as do other regions. The mineral region of the Canadian Shield normally begins as a single node of mining activity. If new centers of mining develop around the original node a dispersed mineral region forms in which there is considerable open space. With the development of a closer knit pattern of mining activities a uniform mining region evolves. Each of these regional types has characteristic features and problems of development.

It is the purpose of this paper to describe and analyse the characteristics of the different stages in mineral regionalism of the Canadian Shield. Such aspects are investigated as production and reserve trends, localization of the processing facilities, problems of establishing a mining economy in a subarctic environment, similarities and contrasts of the mining landscape in different stages of exploitation, population patterns and contrasts in the composition of population between mining and nonmining communities, and the interplay of the mining processes with other elements of the economy. Because there are many regions dominated by minerals in different stages of development, the Canadian Shield presents an ideal area for the study of mineral regionalism. --Auth.

1-2606. Busch, W. L. MINERAL PRODUCTION IN ILLINOIS IN 1958: Illinois State Geol. Survey, Circ. 279, 43 p., 6 maps, 3 graphs, 25 tables, 1959.

The amount and value of minerals produced in Illinois during 1958 and 1957 are summarized in tables, maps, and charts in this annual report. The total value of minerals produced in 1958 amounted to more than 603 million dollars. Revised values for 1957 totaled 612.7 million dollars. The minerals include coal, crude oil, stone, sands and gravel, fluorspar, metals, and such related items as clay products, cement, lime, natural gas, and liquefied petroleum gases. A directory of Illinois mineral producers is included. --Auth.

13. FUELS

See also: Geologic Maps 1-2426, 1-2427, 1-2429; Areal and Regional Geology 1-2438, 1-2446; Geomorphology 1-2463; Structural Geology 1-2467; Stratigraphy 1-2473.

1-2607. Knowles, Ruth Sheldon. THE GREATEST GAMBLERS: 346 p., illus., map on endpaper, New York, McGraw-Hill Book Company, May 1959, refs.

This book is a popular history of oil exploration in America from the Drake well to 1959, told through the stories of the great wildcatters, geologists, and geophysicists. It has been carefully researched, historically and technically, and is filled with anecdote.

The book concentrates on developments since the 1901 Spindletop discovery. The random drilling era is described through the stories and discoveries of such men as Anthony Lucas, Charles Canfield, E. L. Doheny, Mike Benedum, Joseph Trees, Tom Slick, H. F. Sinclair, E. W. Marland, Dad Joiner, and H. L. Hunt in Texas, California, Illinois, Kansas, Oklahoma, Louisiana, and Mexico. The development and contributions of petroleum geology are traced emphasizing the discoveries and ideas of Charles Gould, Wallace Pratt, A. I. Levorsen, Glen Ruby, and Lewis Weeks. The development of petroleum geophysics is told through E. L. DeGolyer's story.

Although this is the story of exploration, the approach used results in a history of the industry, its boom towns, the growth of big companies, the role of the independent, the effect of an abundance of oil on the nation, and oil's importance. The difficulties and odds of oil finding are dominant themes.

The book concludes, quoting authorities, that as much oil remains to be found in America as has been found and that in addition to continued development of scientific prospecting techniques, the most important factor to assure abundant future supply is a favorable economic and political climate fostering the incentive to explore. --Auth.

1-2608. Swift, Gilbert. DIP-LOG COMPUTER CHART: Jour. Petroleum Technology, v. 11, no. 9, p. 23-28, 12 illus., diag., log, Sept. 1959, 4 refs.

A dip-log consists of a set of 3 formation logging curves which register the depths of formation changes at 3 points around the face of the borehole, together with records of the orientation of the logging tool and the diameter of the well. The user of the dip-log must compute from the observed depth differences and the recorded tool orientation data, the amount of the true dip and its direction. The dip-log computer chart is an 8 1/2 X 11 in. printed sheet on which a simple sequence of graphical steps enables the user to obtain the solution. This chart is used with a translucent tracing paper overlay which becomes a permanent and reproducible record of each solution. The principles, design, and method of using the computer chart are described. --M. Russell.

1-2609. Blanpied, B. W. STATISTICS ON NATURAL GAS DISCOVERIES - 1953: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 9, p. 2041-2050, 7 tables, Sept. 1959.

This is the first attempt of the Committee on Statistics of Exploratory Drilling, American Association of Petroleum Geologists, to analyze the natural gas reserves resulting from successful new-field wildcat completions, and to credit reserves of resulting fields to their year of discovery. A similar analysis of oil reserves has been an important part of the annual report for many years. This report may be considered as a sequel to the first study and report of this kind made by Frederic H. Lahee covering reserves resulting from discoveries made during the decade of 1943-1952. This analysis emphasizes the great importance and expansion of gas reserves to industry. 3.12% of the total of new-field wildcat wells during the 7-year period of 1952-1958 resulted in successful gas wells; this was 27.92% of the total of successful completions. A study of the gas reserves found during the years 1943 through 1953 shows that only 54.59% of the so-called successful discoveries resulted in reserves that may be considered to be profitable. --Auth.

1-2610. Alberta, Dept. of Mines and Minerals. ALBERTA OIL & GAS PICTURE - 1947-1958: map, sec. and 2 tables on fold. sheet, Edmonton, Alberta, 1959.

Statistics are given on the exploration, development, production, and distribution of oil and gas for the years 1947 through 1958. A total of 925, 267, 523 barrels has been produced from 102 named and other undefined pools. A map, scale approx. 1 in. to 80 mi., shows the location of Alberta's principal oil and gas fields. --M. Russell.

1-2611. Jackman, C. W. (Dept. of Mines and Minerals, Natural Resources Building, Edmonton, Alberta). 75 YEARS OF OIL AND GAS EXPLORATION AND DEVELOPMENT IN ALBERTA, 1883-1958. BACKGROUND INFORMATION: 25 p., [Edmonton?, 1959?].

The development of Alberta's oil and gas industry is traced from the first gas well, discovered in drilling for water near Alderson in 1883. Early development was accompanied by tremendous waste of gas for which no market was available. Production is closely regulated to protect markets and to insure the orderly development of fields. Geophysical exploration is the most successful method of finding structures because of a nearly complete mantle of glacial deposits. Extensive muskeg restricts exploration to periods when it is frozen hard. Extensive road building and maintenance have been required as development has proceeded. Other related mineral developments have included salt production, products for polyethylene plastics, cement, and bentonite mining. --M. Russell.

1-2612. [Hart, Earl W.] OFFSHORE GEOLOGY AND OIL RESOURCES: California, Div. Mines, Mineral Inf. Service, v. 12, no. 5, p. 1-7, 2 illus., geol. map scale 1:5, 000, 000, May 1959, 18 refs.

The article summarizes the topography, geology, and oil resources of California's offshore lands. Oil has been obtained from these lands for more than 60 years, but only recently have technology, equipment, and law developed to a level that permits exploration of a large portion of this potentially petroliferous region.

Although the offshore geologic features are essentially an extension of the onshore ones, remarkably little detail is known about the submarine geology. More is known of the topography, which is typified by narrow continental shelves, steep continental slopes, and a well-developed continental borderland. The submarine terrain, however, has limited development of the oil resources to shallow water areas relatively near shore, Even so, a wide variety of exploitation methods applied to the inner shelf of southern California have resulted in 578,000,000 barrels of oil being produced through 1958. --Auth.

1-2613. Wengerd, Sherman A. PENNSYLVANIAN OIL POSSIBILITIES OF SAN JUAN BASIN, FOUR CORNERS REGION: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 9, p. 2214-2227, 5 maps, Sept. 1959, 30 refs.

The San Juan basin is a post-Pennsylvanian tectonic subsidence area closely related in its early sedimentational history to the Paradox geosyncline. During early Pennsylvanian time, this region was subjected to widespread erosion, but received high-shelf Pinkerton Trail carbonates and fine gray clastics related to the Cordilleran geosyncline, followed by Cherokee subsidence to form a through-going seaway in whose deeper parts evaporites of the Paradox formation were deposited, succeeded by coarse arkosic clastic invasion from the strongly activated San Luis and Penasco positives on the E. and fine-grained red clastics from the Zuni-Defiance positives on the W. and SW. Normal marine waters persisted during the deposition of the Honaker Trail-late Madera sediments, succeeded by filling of the seaway with red continental clastics across the Pennsylvanian-Permian temporal boundary everywhere except in the medial parts of the seaway where marine Wolfcamp carbonates were deposited. The SW. and W. shelf of this seaway, with its sediment-controlling "spurs" and "sags," appears to be a locale where commerical oil should be present in Pennsylvanian strata. --Auth.

1-2614. North Dakota Geological Society, Bismarck, North Dakota, and Saskatchewan Geological Society, Regina, Saskatchewan. SECOND WILLISTON BASIN SYMPOSIUM, REGINA, SASKATCHEWAN, APRIL 23, 24, 25, 1958: 129 p., illus., maps, secs., diags., graphs, Bismarck, Conrad Publishing Co., [1958?]) refs.

An introductory address and 21 papers deal with the stratigraphy, structure, petroleum exploration and production in the U. S. and Canadian sections of the Williston basin. Papers presented at the symposium are listed below. Titles indicated in capital letters are separately abstracted in the order in which they appear in the symposium.

Link, Theo. A. The Williston Basin is Large and Deep, p. 6-7.

Pye, Willard D. NORTHERN GREAT PLAINS PALEOGEOLOGY AND INTER-STRATIGRAPHIC RELATIONSHIPS, p. 8-16.

Meek, K. S., Jr. PRECAMBRIAN OF THE CANADIAN WILLISTON BASIN, p. 17-19.

Carlson, Clarence G. THE STRATIGRAPHY OF THE DEADWOOD-WINNIPEG INTERVAL IN NORTH DAKOTA AND NORTHWESTERN SOUTH DAKOTA, p. 20-26.

Harrison, Ray, and T. C. Larson. OIL PRODUCTION FROM THE "SPEARFISH" AND CHARLES IN THE NEWBURG FIELD, BOTTINEAU COUNTY, NORTH DAKOTA, p. 27-32.

Porter, J. W., and J. G. C. M. Fuller. SUCCESSION OF LOWER PALEOZOIC ROCKS IN THE NORTHERN PART OF THE WILLISTON BASIN, p. 33-39.

Harris, Steven H. ROCKY RIDGE POOL, BILLINGS COUNTY, NORTH DAKOTA, p. 40-46.

Hansen, Dan E. THE JURASSIC-CRETACEOUS BOUNDARY IN NORTH DAKOTA, p. 47-54.

Cumming, A. D. The Geology of Dollard Field, Saskatchewan, p. 55-58.

Lewis, Paul J., and Maurice H. Smith. THE PHOTOMICROLOG - A NEW SUBSURFACE TOOL, p. 59-63.

Mitchell, P. H., and C. K. Petter. THE LIGNITE FIELD, BURKE COUNTY, NORTH DAKOTA, p. 64-69.

Van Hees, H. THE MEADOW LAKE ESCARPMENT - ITS REGIONAL SIGNIFICANCE TO LOWER PALEOZOIC STRATIGRAPHY, p. 70-78.

Elphinstone, N. P. GEOLOGY OF THE FOSTERTON FIELD, p. 79-84.

van Poollen, H. K., and Sam J. Bateman. APPLICATION OF FORMATION TESTING TO HYDRODYNAMIC STUDIES, p. 85-93.

Nesbitt, J. STEELMAN FIELD, SOUTHEASTERN SASKATCHEWAN, p. 94-99.

Smith, O. J. E., and T. M. Wilson. STEELMAN MIDALE BEDS RESERVOIR WATERFLOODING PROSPECTS, p. 100-104.

Cheesman, R. L. The History and Geology of Potash Deposits in Saskatchewan, p. 105-108.

Mollard, John D. PHOTOGEOPHYSICS, ITS APPLICATION IN PETROLEUM EXPLORATION OVER THE GLACIATED PLAINS OF WESTERN CANADA, p. 109-117.

Kupsch, W. O. Surface Structures in Southern Saskatchewan, p. 118-126.

Lewis, Paul J. A Preliminary Report on the Outlook Field, Sheridan County, Montana (abstract only), p. 127.

Roe, Willian H. Pressure Maintenance Performance by Water Flood in the Dollard Field (abstract only), p. 128.

Edie, Ralph W. Middle Devonian Elk Point Group and Dawson Bay Formation, Central Saskatchewan, (abstract only), p. 129.

1-2615. Pye, Willard D. NORTHERN GREAT PLAINS PALEOGEOLOGY AND INTER-STRATIGRAPHIC RELATIONSHIPS (In: North Dakota Geological Society and Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 8-16, 33 maps, Bismarck, Conrad Publishing Co., [1958?]) ref.

An economic deposit, whether oil, gas, saline, metallic, nonmetallic or otherwise, will occur where there has been the right combination, for the given type of deposit, in space and time of physical and chemical environments and of tectonic activities. Therefore, the location of a given type of economic deposit necessitates first knowing the "habitats" or the environments in which the given type of deposit can occur, and then the location of areas which have the proper sequence of geological events to give that environment.

Certain of the factors controlling the accumulation of petroleum are known. This paper presents some of the results of regional and local geological investigations covering some stratigraphic environments which may be of importance in controlling the occurrence of oil and gas in the northern Great Plains, and in particular along the eastern side of the Williston basin.

The region under discussion lies upon a shallow marine shelf located between the relatively stable Canadian Shield on the E. and the active Cordilleran geosyncline on the W. It is a region which was subjected to repeated warpings. These warpings produced local basins of deposition filled with varying types of sediments which may be uniform over wide areas or which may have different interfingering facies. Some of the areas of deposition were separated by shoal areas or by regions of uplift and erosion. At various times the entire area was regionally uplifted and subjected to widespread beveling.

Within the area petroleum has been discovered in both structural and stratigraphic traps. Although a wide variety of stratigraphic types of traps are present in the region, the present paper will confine itself to a discussion of the pinch-out and unconformable relationships of various portions of the stratigraphic section. However, since in many cases localization of petroleum accumulations within a stratigraphic trap may be controlled by structure, the correlation of structure with the geological period in which it originated, and through its various stages of development in the potential stratigraphic trap area, is significant and must be determined.

A knowledge of the relationship of overlying to underlying strata, the lithology, physical properties, and the past physical history of the beds which are in contact with each other may be controlling factors in determining the economic potentialities of any stratigraphic trap. Therefore, within the area the relationship of each group of beds immediately overlying and immediately underlying each geological group of beds being analyzed is considered. --Auth.

1-2616. Meek, K.S., Jr. PRECAMBRIAN OF THE CANADIAN WILLISTON BASIN (In: North Dakota Geological Society and Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 17-19, map, Bismarck, Conrad Publishing Co., [1958?]) 13 refs.

Precambrian structure and basement rock identifications in conjunction with Paleozoic samples, isopachs, and facies maps have been used to assess the significance of the Precambrian in petroleum exploration in the Canadian Williston basin. Petrographic provinces are delineated in the subsurface and compared to those already described on the Shield and in the subsurface of Alberta. There seems to be a relationship between basement lithology and Precambrian paleotopography. Some of the recognized faults in overlying sediments may originate in the basement. --Auth.

1-2617. Carlson, Clarence G. THE STRATIGRAPHY OF THE DEADWOOD-WINNIPEG INTERVAL IN NORTH DAKOTA AND NORTHWESTERN SOUTH DAKOTA (In: North Dakota Geological Society and Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 20-26, 6 maps, 4 secs., 2 charts, Bismarck, Conrad Publishing Co., [1958?]) 21 refs.

The pre-Winnipeg sedimentary rocks of North Dakota and northwestern South Dakota are referred to as the Deadwood formation. The Deadwood formation, as defined in this paper, ranges in thickness from being absent in northeastern North Dakota to a maximum of 800+ ft. in western North Dakota. It is composed of sandstone, carbonate rocks, and shale of Upper Cambrian and Lower Ordovician age. A division into Upper Cambrian and Lower Ordovician formations is not feasible at this time since sedimentation appears to have been continuous from Upper Cambrian to Lower Ordovician time.

The Winnipeg formation of this area consists of sandstone, shale, and siltstone ranging in thickness from zero at its erosional edge in eastern North Dakota to a maximum of 334 ft. in northwestern North Dakota. The Winnipeg formation lies unconformably on the Deadwood formation except in northeastern North Dakota where it lies on Precambrian rocks. The Winnipeg formation is overlain conformably and gradationally by the Red River formation.

The Winnipeg formation in North Dakota may be divided into 3 members. Comparisons of the subsurface members to the outcrops in the Black Hills indicate that the siltstone and shale units underlying the Whitewood dolomite of the outcrop area are equivalents of the upper 2 members of the Winnipeg formation. Therefore the terms Roughlock and Icebox, which have previously been applied to these units in the outcrop area, are here applied to the Winnipeg formation in the subsurface of the Williston basin. The basal sandstone member of the Winnipeg formation does not have an equivalent in the Black Hills outcrop section.

The relationship of the Winnipeg formation of the Manitoba outcrop area to the subsurface cannot be as clearly demonstrated. The term Black Island has been previously applied to the basal sandstone member in the outcrop area of Manitoba and in the subsurface of the Williston basin. Although the upper contact may not be the same in the outcrop as in the subsurface, this usage is herein accepted. --Auth.

1-2618. Harrison, Ray, and T.C. Larson. OIL PRODUCTION FROM THE "SPEARFISH" AND CHARLES IN THE NEWBURG FIELD, BOTTINEAU COUNTY, NORTH DAKOTA (In: North Dakota Geological Society and Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 27-32, 8 maps, 2 secs., Bismarck, Conrad Publishing Co., [1958?]).

The Newburg field which lies on the E. flank of the Williston basin has obtained the first significant production from the shallow Jura-Triassic "Spearfish" section in this basin. This red clastic section lies unconformably upon truncated Charles (Mississippian), and the 2 formations serve as a common reservoir through stratigraphic entrapment.

The reservoir of the "Spearfish" section is a very fine-grained quartz sandstone, interbedded with silts and shales, which ranges in thickness from 40 ft. to an updip wedge-out. The Charles portion of the reservoir is an 18-ft. bed of buff, fragmental, partly oölitic, and argillaceous limestone. Porosities and permeabilities vary greatly but are fairly low.

The Charles at the Newburg field lies in a synclinal position, and the transgressing basal sands of the "Spearfish" section were deposited in this trough, wedging out updip and laterally to form a stratigraphic trap. The Charles pay section, which also wedges out by truncation, is believed to be the carrier beds from which the oil "leaked" into the overlying "Spearfish."

Currently there are 25 wells in the Newburg field, the majority of which are producing from both the "Spearfish" and underlying Charles. Some producers are completed only in either the "Spearfish" or Charles. Production rates vary from 75 to 125 barrels of oil per day. --Auth.

1-2619. Porter, J.W., and J.G.C.M. Fuller. SUCCESSION OF LOWER PALEOZOIC ROCKS IN THE NORTHERN PART OF THE WILLISTON BASIN (In: North Dakota Geological Society and Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 33-39, 3 maps, 4 secs., 2 charts, Bismarck, Conrad Publishing Co., [1958?]).

In the existing northern Williston basin, the northwestern flank only of the Red River is preserved. Judging by the distributions of the central and marginal facies the original depositional area extended northwestward to the site of Hudson Bay and southwestward to the site of the Little Rocky, Big Snowy, and Bighorn mountains. The sources contributing sands and shales to the Deadwood and Winnipeg seem to have been inundated, for the Red River limestones in the central and eastern parts of the area record steady subsidence along an E.-W. axis, uninterrupted by incursions of terrigenous clastics until the onset of evaporitic deposition during upper Red River times. These evaporitic pauses imposed a rhythmic variation of lithology on the sediments, and each evaporitic standstill was both preceded and succeeded by thin though very widespread argillaceous deposition. The site of the tectonic disturbance (and probably of the argillaceous material) lay in a growing (Sioux?) upwarp along the southeastern margin of the basin.

Two complete cycles of standstill and resubmergence passed before an upwarping surge distributed increasingly widespread sheets of Stony Mountain shale into the southeastern part of the basin. The upwarp shifted the center of ensuing sedimentation about 100 mi. northwestward and swung the axis of thickest accumulation into a northeasterly direction, but it failed to disrupt the established carbonate regime. During its dying pulses sedimentation returned to rhythmic evaporite sequences; connections with the Hudson Bay and Bighorn areas were probably weakened, and new sources of detrital material were available. At least twice during Gunton-Stonewall times incursions of coarse frosted sand grains, quartz silts, and clay, evidently borne by scouring currents strong enough to remove small pebbles from the sedimentary surface, spread over the basin. The source of the sand influx is unknown, although the Winnipeg formation, possibly exposed on the crests of the basin-limiting peripheral upwarps on the eastern (Transcontinental arch) side, is likely.

Interlake group times opened with a resurgence of uplift around the eastern periphery sufficiently strong to shift the center and axis of maximum sedimentation westward, but subsidence at the center weakened, rhythmic pauses of evaporite deposition ceased, and uniform "lagoonal" dolomite mudstones covered the basin. Reef-builders flourished in the eastern shallows, though their colonies grew no more than a few feet high. New scouring influxes of coarse frosted quartz-sand (perhaps reinforced from northern sources) entered the basin during mid-lower, top lower and mid-middle Interlake times. Carbonate sedimentation was little disturbed, but the peripheral upwarps supplying the sands pushed the central axis of the basin past the N.-S. line almost to the site of the Middle Devonian axis. So far as is known a final basinwide uplift brought the Interlake deposits to emergence and erosion which lasted until Middle Devonian times. --Auth. summ.

1-2620. Harris, Steven H. ROCKY POOL, BILLINGS COUNTY, NORTH DAKOTA (In: North Dakota Geological Society and Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 40-46, 2 maps, 3 secs., Bismarck, Conrad Publishing Co., [1958?]) 8 refs.

The Rocky Ridge pool, Billings County, North Dakota, was discovered in Jan. 1957. The field, a stratigraphic trap, produces from a lower Pennsylvanian sandstone lens and is important primarily because of the stratigraphic implications of the producing horizon. The pool is in the earliest stages of development, with 3 producing wells and 4 dry holes defining the pool limits.

The producing interval is believed to be a bar-type sand buildup deposited in a shallow sea in early Pennsylvanian time. A widespread black shale-sandstone sequence resting on truncated Otter (Mississippian) formation in the Rocky Ridge area, represents a marker-defined operational unit lying between the truncated Mississippian and a gray limestone marker bed in the Amsden formation.

Preliminary paleontological examination of the lower Amsden operational unit reveals a lower Pennsylvanian fresh water faunal assemblage including ostracods considered to be a marker of the true Amsden (Pennsylvanian) formation of Wyoming. --Auth.

1-2621. Hansen, Dan E. THE JURASSIC-CRETACEOUS BOUNDARY IN NORTH DAKOTA (In: North Dakota Geological Society and Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 47-54, 11 maps, 6 secs., Bismarck, Conrad Publishing Co., [1958?]) 4 refs.

The study of a limited amount of subsurface stratigraphic section associated with the Jurassic-Cretaceous transition in North Dakota has resulted in a new interpretation of the boundary. The Jurassic-Cretaceous contact is postulated to be gradational for the most part rather than at an unconformity. A hypothetical time line, arbitrarily placed by stratigraphic position, is used to demarcate the boundary.

An arbitrary Upper Jurassic time-rock unit, terme Jurassic XB, of varied lithology is used for this report. The XB unit of western North Dakota is correlative with the marine Swift formation of Montana. The XB unit in southwestern North Dakota is more arenaceous and gradually changes to the characteristics of the marine Sundance formation in the northern Black Hills. In S.-central North Dakota the XB unit is also correlative with the Sundance formation. However, in the eastern and N.-central areas of North Dakota the XB unit changes in lithology and consists of marine sandstones, greenish-gray and gray shales, and light gray siltstones that grade, in an eastern direction, laterally and vertically into partly nonmarine quartzose sandstone and gray shale units. It must be emphasized, herein, that the quartzose sandstone and gray shale units have previously been termed, by lithologic criteria only, the Lakota and Fuson formations, respectively. Furthermore, in northeastern North Dakota the XB unit includes gray, greenish-gray, and varicolored shales, and light gray silts that are at least partly nonmarine. The contact of the XB unit and the underlying Rierdon formation is gradational in northwestern North Dakota and is placed at a prominent point on the electric and/or gamma ray logs. In other parts of North Dakota the contact is at an unconformity. The Rierdon-XB boundary is thought to be a time line, because it is delimited by an unconformity of low angularity in eastern and southern North Dakota and an equivalent widespread "marker horizon" in northwestern North Dakota.

The sediments of the Cretaceous interval studied also show definite facies relationships. The unit overlying the Jurassic XB is termed the Cretaceous YA and consists of fine- to very coarse-grained quartzose sandstones and gray shales of marine to nonmarine environments. The Fall River sandstone is, timewise, the only persistent and mappable formation of the YA unit. The units overlying the Cretaceous YA are, in ascending order, the marine Skull Creek shale, the marine to nonmarine Newcastle

dstone, and the marine Mowry shale. The upper
it of the stratigraphic interval studied is placed
a prominent point on the gamma ray log and is at
base of an arenaceous, bentonitic bed included
he overlying Belle Fourche shale.

The epeirogenic movement that controlled the
osition of the Jurassic sediments studied can best
described as a gradual uplift with intermittent sub-
ence. Conversely, the epeirogenic movement that
trolled the deposition of the Cretaceous sediments
died can best be described as a gradual subsidence
h intermittent uplift.

The lithologies and environments discussed in this
ort are time transgressive. Tectonics of a re-
nal nature controlled the sedimentation, and as a
ult the lithologies and, therefore, environments
he Jurassic appear to be chiefly time transgres-
e in a western direction in North Dakota. The
rlying Cretaceous lithologies appear to be chiefly
e transgressive in an eastern direction. The
assic-Cretaceous boundary is then wrapped in a
tory of regional tectonics. This boundary is ar-
rarily placed within a gradational contact in North
kota, but in other areas along the basinal flanks
Jurassic-Cretaceous boundary certainly appears
be at an unconformity. --Auth.

**622. Lewis, Paul J., and Maurice H. Smith.
E PHOTOMICROLOG - A NEW SUBSURFACE
OL (In: North Dakota Geological Society and Sas-
chewan Geological Society. Second Williston Ba-
Symposium...: p. 59-63, illus., map, 5 logs,
rt, Bismarck, Conrad Publishing Co., [1958?]).**

In the study of carbonate rocks with the binocular
croscope, large features can adequately be ob-
rved, but most fine components and their textural
rangement are difficult if not impossible to deci-
er. The photomicrolog has been developed and
ced in production as a solution to some of the
blems encountered by logging geologists.

The photolog portion is composed of photomicro-
phs of rock thin sections prepared from core and
ll chips. The photolog depicts, by means of suc-
ssive photomicrographs, the details of the lithol-
in a selected stratigraphic series of rocks. The
tomicrograph enlargement is X10.

Thin sections vividly reveal the composition and
ture of carbonate rocks. A rapid, yet relatively
curate, porosity evaluation can be attained. Also,
m the photolog portion, an accurate determination
he environment of depositions can be made. The
tomicrolog and the techniques employed therein
be applied both regionally and locally. --Auth.

**623. Mitchell, P.H., and C.K. Petter. THE
GNITE FIELD, BURKE COUNTY, NORTH DAKOTA
North Dakota Geological Society and Saskatchewan
ological Society. Second Williston Basin Symposi-
...: p. 64-69, 5 illus., 5 maps, sec., log, Bis-
rk, Conrad Publishing Co., [1958?]) 4 refs.**

Accumulation of oil in the Lignite field is controlled
stratigraphic changes which occur over low order
uctural noses. This is the first significant oil
d to produce from the Midale beds of the Charles
mation of Mississippian age in an area where the
umulation is not affected by the truncation of po-
ity at the Paleozoic unconformity.

Lithology of the Charles indicates probable depo-
on of the entire formation in a predominantly pene-
ne environment. The pay unit may be easily divided into 4 major lithotopes which are illustrated and described. A structure map contoured on the top of the Midale pay shows that the main producing portion of the field is located on a broad, gentle, SW.-plunging nose.

The reservoir is characterized by relatively high connate water saturation and slightly sulfurous crude. As of Feb. 1, 1958, 20 wells had produced 90,000 barrels of oil, and no dry holes had been drilled in the main field area. --Auth.

1-2624. Van Hees, H. THE MEADOW LAKE ESCARPMENT - ITS REGIONAL SIGNIFICANCE TO LOWER PALAEOZOIC STRATIGRAPHY (In: North Dakota Geological Society and Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 70-78, 3 illus., 6 maps, 2 secs., Bismarck, Conrad Publishing Co., [1958?]) 36 refs.

The Meadow Lake escarpment in NW. Saskatchewan is an erosional lineament that originated during the sub-Devonian unconformity interval. At that time, Silurian, Ordovician, and 1,000 ft. of Cambrian rocks were removed from the area N. of the escarpment. During the sub-Devonian interval the Saskatchewan plains formed an elevated area (Prairie plateau) which was attacked by active erosion from the N. This erosion was apparently stopped along the slightly arcuate trend of the Meadow Lake escarpment.

The earliest marine Devonian, the lower Elk Point of the Ulsterian series, approached from the N. and NW. but did not extend over the Prairie plateau, which remained a positive area until Winnipegosis, Erian time.

The escarpment has been projected E. and W., following the erosional northern margin of the Ordovician carbonates. The eastern projection has a trace parallel over 120 mi. with an important Precambrian fault system, the Kisseynew lineament of the Flin Flon area. It is suggested that this lineament, which ties in across the shield with the boundary between the Precambrian Churchill and Superior provinces, provides the tectonic background and hinge line, which gave the linear character to the escarpment. It is a belt of faults, thrusted from the N., accompanied by N.-S. trending faults of later date, with vertical as well as horizontal movements.

Factual proof of faults in the Precambrian subsurface of the Meadow Lake area is not found, but there are indications that suggest faulting. Both salt solution and movements along reactivated Precambrian faults are possible interpretations, in addition to the effect of the hinge line, which controls the regional picture.

The lower Elk Point is pre-Ashern Devonian of the Ulsterian series, not present in the Williston basin. It has assumed counterparts in many pre-Winnipegosis, post-Silurian formations in western Canada, which are mostly nonfossiliferous. An ostracod fauna (Welleria and Welleriopsis) in the lower Elk Point suggests an age relation with the fossiliferous (Abitibi) limestone group of the James Bay lowland, which, according to recent publications, belongs to the Onesquethaw stage of the Ulsterian series, which correlates with the Lower Devonian Coblenzian of Europe.

A number of formations of questionable age, which appear to be possible equivalents of the lower Elk Point, have been outlined on a framework map. It is hoped that this map may be of assistance in visualizing to some extent, the source, environment, and basin structure during the first Devonian transgression of the Ulsterian seas. --Auth.

1-2625. Elphinstone, N.P. GEOLOGY OF THE FOSTERTON FIELD (In: North Dakota Geological Society and Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 79-84, 4 illus., 5 maps, Bismarck, Conrad Publishing Co., [1958?]) 11 refs.

Oil production in the 2 pools of the Fosterton field is obtained from the Roseray sand formed by the reworking of the middle Vanguard sand near its subcrop edge. This sand was deposited on a pre-Roseray sand structure on the lower Vanguard, shortly after the last major Jurassic marine transgression in the Fosterton area.

The Roseray sand is comprised of 2 units: Roseray Sand I, formed as an offshore bar, and Roseray Sand II, a barrier beach deposit. This sand grades laterally to the W. and N. into fine clayey impervious sediments and upwards to a shale and tight Fosterton and Cantuar sand with the eastern and southern limits being controlled by oil/water interfaces. One or possibly 2 major disconformities and several minor diastems occur in the producing column of this field between the lower Vanguard and Cantuar Marker time. The good porosity, permeability, and the thickness of sands in the Roseray reservoir make it the most prolific oil field found to date in this area.

Finally, the discovery of the Fosterton field has given a great impetus to exploration in Saskatchewan that is just now beginning to recede. --Auth. concl.

1-2626. van Poollen, H.K., and Sam J. Bateman. APPLICATION OF FORMATION TESTING TO HYDRODYNAMIC STUDIES (In: North Dakota Geological Society and Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 85-93, 27 figs. incl. 19 graphs, Bismarck, Conrad Publishing Co., [1958?]) 12 refs.

The conventional method of petroleum exploration has been to search for structural and stratigraphic traps. It was thought that the surfaces between the water and oil and between the oil and gas would be essentially horizontal planes. These assumtions will only hold in their entirety if a hydrostatic condition exists in the formation. Under hydrodynamic conditions, i.e., when the water moves through the formation (as is frequently the case), the above surfaces will become inclined and the traps will not necessarily occur at structural "highs."

In this paper, the principles of hydrodynamic studies in relation to petroleum exploration are briefly reviewed, and the basic data for this type of study are discussed. The most sensitive of these data are the formation fluid pressure measurements. One of the better methods to obtain pressure measurements is formation testing. The tools of formation testing are briefly discussed with special emphasis on the accuracy of pressures. Suggestions are made to improve the accuracy of pressure measurements and the interpretation of such pressures. --Auth.

1-2627. Nesbitt, J. STEELMAN FIELD, SOUTHEASTERN SASKATCHEWAN (In: North Dakota Geological Society and Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 94-99, 4 illus., 5 maps, 3 secs., Bismarck, Conrad Publishing Co., [1958?]) 8 refs.

Steelman is a stratigraphic type oil field with a developed area of over 70 sq. mi. at the end of 1957. Although there are 2 producing reservoirs, the Midale has much greater lateral extent and carries over 90% of the reserves. This reservoir is thin and somewhat variable in quality and is characterized b comparatively high porosity and low permeability. A trap is provided at the updip truncation of the Mid ale at the Paleozoic unconformity. Local accumulations in the Frobisher beds are trapped by porosity variations along minor structural trends. --Auth.

1-2628. Smith, O.J.E., and T.M. Wilson. STEEL MAN MIDALE BEDS RESERVOIR WATERFLOODIN PROSPECTS (In: North Dakota Geological Society ar Saskatchewan Geological Society. Second Williston Basin Symposium...: p. 100-104, 2 maps, diag., 8 graphs, Bismarck, Conrad Publishing Co., [1958?]

It is evident from this study that waterflooding in Steelman [field, 150 mi. SE. of Regina, Saskatchewan] could substantially increase reserves. Howeve low injectivity or the presence of an oriented fractu system could render a field-wide waterflood uneconomic. To investigate the effect of any such anoma ous reservoir characteristics, a pilot waterflood preceding field-wide flooding was proposed by Imperial Oil Ltd. to the operators of a 9-section area. A 10-acre pilot has been planned using Imperial Steelman 11-17 as the center producing well. To protect both royalty and working interest owners, a 9-section area around the pilot was unitized. Pilot results should be available for extrapolation to the remaining portions of the Steelman field approximat ly one year after initiation of water injection. --Aut concl.

1-2629. Mollard, John D. PHOTOGEOPHYSICS, ITS APPLICATION IN PETROLEUM EXPLORATIO OVER THE GLACIATED PLAINS OF WESTERN CA ADA (In: North Dakota Geological Society and Saska chewan Geological Society. Second Williston Basin Symposium...: p. 109-117, 6 illus., 2 maps, 2 diags., Bismarck, Conrad Publishing Co., [1958?] 38 refs.

Over extensive areas of the drift-covered Canadi prairies, suitably scaled high-resolution aerial mosaics reveal structurally controlled surface fractur patterns. Similar surface fracture patterns have been observed in the heavily vegetated, muskeg-dotted northern region of northern Alberta and the Nor west Territories.

An appreciation of the techniques of observing and mapping fractures and airphoto interpretation e perience in glaciated regions are necessary in orde to identify confidently the great majority of subtle linear traces recorded on aerial photographs.

Past studies involving the mapping, analysis, an interpretation of areal fracture data from aerial ph tography indicate that a well-integrated approach h considerable merit in petroleum exploration. This especially true in areas where the subsurface geolo is little known and accessibility problems are difficult or hazardous.

The study of surface fracture patterns mapped from aerial photos is a tool that is being used more and more in the search for significant subsurface variations. To derive optimum results it must be employed with considerable experience and judgme Like other tools used in prospecting and exploratio work, aerial fracture study is better adapted to so areas and under some circumstances than others. For this reason its potential probably will not be fully known or fully exploited for some years to come. Only continued application under a variety geologic circumstances will answer the yet unknow questions. Like other subsurface exploration techniques, aerial fracture studies are rarely expected to stand alone.

When the full potential of aerial fracture study is known it is expected to play its principal role in the preground-geophysical stages of an integrated subsurface exploratory program. But in general it should be employed whenever and wherever it best serves in attaining a particular objective. The writer feels that, for the present time at least, a flexible approach rather than a preconceived rigid one should be followed in determining the various ways of analyzing and interpreting aerial fracture data. Certainly one of the most straightforward approaches is to relate variables of regional systematic fracture patterns to underlying structure in areas of extensively exposed bedrock terranes, then inspect and analyze the raw surface fracture data in masked bedrock areas with a view to detecting the well-established observed relationships. --Auth. summ.

1-2630. Ardmore Geological Society, Ardmore, Oklahoma. PETROLEUM GEOLOGY OF SOUTHERN OKLAHOMA, A SYMPOSIUM; SPONSORED BY THE ARDMORE GEOLOGICAL SOCIETY. VOLUME II: 341 p., illus., maps (2 in pocket), secs. (1 in pocket), graphs, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959, refs.

The second volume in this series (Vol. 1, 1956) contains 17 papers. Each paper is separately abstracted below in the order in which it appears in the symposium.

1-2631. Tomlinson, C.W., and Willian McBee, Jr. PENNSYLVANIAN SEDIMENTS AND OROGENIES OF ARDMORE DISTRICT, OKLAHOMA (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 3-52, 11 figs. incl. illus., 7 maps, secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 46 refs.

During Pennsylvanian time, the Ardmore basin was the site of almost continuous deposition in long, narrow, and often deep basins lying in close proximity to structurally and topographically high islands. These islands and seamount archipelagoes formed and were rejuvenated during the several orogenic pulsations that mark the Pennsylvanian period in southern Oklahoma as one of exteme unrest. As the islands were upfolded, they were truncated, and some of them buried - partly in their own detritus.

The base of the Pennsylvanian is drawn at the base of the Rod Club sand. The underlying Goddard shale, which was formerly included in the Springeran series, is now considered to be Chesterian in age. The Springeran series as defined herein is apparently restricted to the Ardmore-Anadarko basin with only a very thin wedge, if any, within the western McAlester basin. It consists of shales with sandstone members, in many places oil bearing, which are "regionally persistent but locally very erratic" (Hubbard and Thompson).

The Morrowan series began with a very widespread "transgression" of marine sands that covered the peneplained surface of most of Oklahoma N. of the Wichita Mountains-Criner Hills axis, and extended NW. into southwestern Kansas and the Texas Panhandle. This was followed by marine shales and then limestones. Local uplifting (Wichita orogeny) began in the Criner Hills, and elsewhere, possibly during late Springeran time, and increased in magnitude in the Morrowan epoch, producing coarse conglomerates E. of the Criner Hills. It culminated in early Atokan time in intricate folding and faulting. These folds lie en echelon, with their axes about 10° from the major tectonic trend. Many of the upfolded insular structures that now contain vast amounts of oil were first formed during this period of unrest. Concomitant erosion of these islands stripped as much as 8,000-13,000 ft. of sediments from many of them before their burial in late Des Moinesian time.

The Atokan series began with the deposition of thick conglomerates in the vicinity of the Criner Hills. Marine shales, sands, and some limestones make up the rest of the unit. Near the end of the epoch the Ouachita orogeny intensely compressed the Ouachita geosyncline to the E., raising the Ouachita Mountains into fairly high relief.

The Des Moinesian rocks of the Ardmore basin tell the erosional story of that land mass. Great wedges of chert conglomerates, sands, and deltaic sediments extend northwestward into the Ardmore basin, where they intertongue with swamp and marine strata. The marine sands contain tremendous quantities of oil, in structurally high positions. Around the island uplifts, a considerable accumulation of locally derived detritus was deposited. The presently exposed Arbuckle Mountains were strongly uplifted in late Des Moinesian time (first major phase of the Arbuckle orogeny), shedding detritus into adjacent submerged areas.

An interval without severe tectonism resulted in slow subsidence of most of the region in Missourian time, with an influx of transgressive marine shales, sands, and limestone, interbedded with a few tongues of continental sediments. By the end of Missourian time most of the structural islands were completely buried. The end of this epoch was marked by the culmination of the Arbuckle orogeny, with great uplift in the Arbuckle Mountain area and intense compression of the Ardmore basin, continuing into Virgilian time. Close folding accompanied by major faulting occurred at this time.

The Virgilian series consists largely of terrestrial and shallow-water conglomerates and red shales that were deposited in the low areas surrounding the eroding mountain ranges that were formed during the Arbuckle orogeny. By the end of Virgilian time, both the erosional and the depositional surfaces were nearly flat. --Auth.

1-2632. Bradfield, H.H. PETROLEUM GEOLOGY OF GRAYSON COUNTY, TEXAS (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 53-100, 18 figs. incl. 9 maps, secs., table, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 19 refs.

Grayson County is located in the eastern part of N.-central Texas, adjacent to the Red River. Sherman, the county seat, is about 70 mi. N. of Dallas. Although occasional wildcat wells had been drilled in the county since early in the century, the first commercial oil pool, the Handy field, was not discovered until 1946. Development has been active since that time, particularly since the discovery of Oil Creek production in the Sandusky field in 1950. As a result, 15 oil fields with about 65 different pay zones have been discovered.

The main regional geological features are: Muenster arch, Marietta basin and associated Gordonville trough, and Ouachita facies of the eastern portion of the county. The Gordonville trough in the NW. portion of the county extends in a NW.-SE. direction paralleling the Muenster arch, and conforming generally to the structural grain established by the Wichita and Arbuckle orogenies in southern Oklahoma. The Sandusky platform, on which a substantial portion of the production in Grayson County is located, borders the Gordonville trough on the SW. and owes its existence to a series of tremendous faults stepping down into the trough. In the southwestern quarter of Grayson County the Ordovician (Ellenburger) beds dip northeastward away from the crest of the Muenster arch, which lies further southwestward in northern Denton and southern Cooke counties. The geologic structure of the area is strongly influenced by faults, the major ones associated with subsidence of the Marietta basin and the minor ones connected with more local adjustments. The Sherman anticline is the largest anticlinal feature in the county, being about 12 mi. long and having approximately 2,000 ft. of closure.

The stratigraphic column includes beds from Gulf and Comanchean rocks at the surface down to probable Cambrian - possibly as much as 35,000 ft. of sediments in the Gordonville trough. Cretaceous rocks rest on Pennsylvanian from Virgilian to Morrowan with great angular unconformity. Pennsylvanian from Deese down to lower Dornick Hills (or possibly Springer) rests with great angular and erosional unconformity on Mississippian (Woodford) down to Ordovician Ellenburger. Most of the oil is found in sands of Des Moinesian age - Deese (Strawn) - upper Dornick Hills; Atokan - middle Dornick Hills; and Simpson (Ordovician) - Oil Creek sand. Four oil fields, Handy, Sandusky, Big Mineral, and Sherman, are briefly described as examples of structure, stratigraphy, accumulation, and character of the production in the area. --Auth.

1-2633. Maxwell, Robert W. POST-HUNTON PRE-WOODFORD UNCONFORMITY IN SOUTHERN OKLAHOMA (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 101-126, 7 maps, 5 secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 4 refs.

The post-Hunton unconformity in southern Oklahoma is evidenced by the age of the rocks encountered at the base of the Woodford shale. A pre-Woodford distribution study illustrates the magnitude of pre-Mississippian folding and suggests a tectonic framework for delineating pre-Woodford structural trends. An isopachous study of the Hunton suggests that the first pronounced structure building in southern Oklahoma occurred during middle Hunton time, at the close of the Silurian period. The Hunton exhibits radical variations in thickness as a result of truncation at the basal Woodford unconformity and also the unconformities and facies changes within the Hunton group. Woodford rests unconformably on rocks ranging in age from Arbuckle, in the Hollis basin in SW. Oklahoma, to upper Hunton in S.-central Oklahoma. A unique carbonate sequence attaining a maximum thickness of 115 ft. in the subsurface occurs at the base of the Woodford shale, and rests unconformably on beds as old as Viola along the Mannsville-Aylesworth anticlinal trend in S.-central Oklahoma. This carbonate occurrence, its lithologic description, and its possible relationship with the outcrop are briefly discussed. --Auth.

1-2634. Reed, Billy Kirk. PRE-ATOKAN UNCONFORMITY OF PORTIONS OF LOVE AND CARTER COUNTIES, OKLAHOMA (In: Ardmore Geological Sc ciety. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 127-141, 5 maps (2 in pocket), secs. (1 in pocket), Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 11 refs.

The pre-Atokan rocks were investigated by determining the geology of the surface of the large pre-Atokan unconformity, including the areal distribution of formations at this surface, and the present structural position of this unconformity. A pre-Atokan paleogeologic map, a structure map on the pre-Atok unconformity, and cross sections drawn to true scal were constructed by using data from well samples an electric-log correlations. In the construction of thes paleogeologic map an attempt was made to project the contacts of the surface rock units, which are exposed in the Criner Hills, into the subsurface.

As established by earlier investigations, the original pre-Atokan surface was developed during the Wichita orogeny in early Pennsylvanian time, and the present subsurface structure of the area was develop both then and during the Arbuckle orogeny in late Pennsylvanian. The constructed paleogeologic map definitely shows that the structural trends of the Criner Hills, formed during the Wichita orogeny, extend to the NW. and SE., in the subsurface. The ma contoured on the pre-Atokan unconformity shows evidence that during the Arbuckle orogeny the area was again folded and faulted along the former tectonic trends, and some completely new structures were formed. In some cases, faulting during the Arbuckle orogeny was along the planes of earlier established faults, but the movement was in the opposite direction. --Auth.

1-2635. Edwards, Acus R. FACIES CHANGES IN PENNSYLVANIAN ROCKS ALONG NORTH FLANK OF WICHITA MOUNTAINS (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 142-155, 7 illus., 2 maps, 5 secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959)

The area of investigation in southwestern Oklahoma extends from the Cement field, Tps. 5-6 N., Rs. 9-10 W., northwestward along the N. flank of the Wichita Mountains to the Oklahoma-Texas boundary. A study of Pennsylvanian sediments in this area reveals conspicuous facies changes both laterally and normal to the mountain flank. The lateral facies changes show a close relationship to the provenance from which the sediments were derived. Correlation difficulties are amplified because of these facies changes. Fusulinids provide reliable age determinations where present. The Pennsylvanian rocks are dominantly clastics; the principal facies near the mountain front is granite wash, a coarse clastic sediment composed primarily of igneous rock fragments with variable amounts of detrital carbonates and chert; subordinate facies are arkosic sandstones, arenaceous, silty shales, and thin, argillaceous limestone. These continental and transitional facies inte finger basinward with normal marine sandstones, shales, and limestones. The study reveals that regionally the reservoir characteristics are largely controlled by the source areas of clastic sediments. The best reservoir development is found in the western part of the area where the provenance is predominantly granitic rocks. --Auth.

1-2636. Prestridge, Jefferson D. SUBDIVISIONS OF SYCAMORE FORMATION (In: Ardmore Geological

Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 156-164, map, sec., 2 tables, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 8 refs.

In the Ardmore basin the Sycamore formation [Mississippian] occupies the stratigraphic interval between the Caney (Meramecian) and Woodford (uppermost part = Kinderhookian) formations. The Sycamore is divisible into 2 members, herein named the Cornell Ranch (lower), and Worthey (upper). The Cornell Ranch comprises up to 80 ft. of silty to sandy, clayey, cherty limestones, dolomitic claystones, and dark gray, calcareous, clayey shales; with a soft, green shale, locally pyritic and glauconitic at the base, lying with apparent conformity upon the Woodford. The Worthey member comprises approximately 310 ft. of compact, tough, blocky, slate blue, silty to sandy limestone, massive at the base, thick bedded near the middle, and thin bedded toward the top; eastward from the type locality, the upper portion gives way to the lower Caney shale. The massive portion of the Worthey forms the prominent Sycamore hogback.

Faunal evidence is lacking for a definite determination of the age of the Sycamore, and for many years it has been arbitarily assigned to the Osagean. No attempt is made in this paper to clarify the age relationships. --Auth.

1-2637. Ryniker, Charles, C.G. Shortridge, and Robert W. Maxwell. ALTUS FIELD, JACKSON COUNTY, OKLAHOMA (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 165-179, 4 maps, sec., log, 4 tables, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 3 refs.

The Altus field, Jackson County, Oklahoma, is about 3.75 mi. long, and averages 1.5 mi. in width. The field was discovered in 1934. The cumulative production to Feb. 1, 1956, was 3, 773, 189 barrels of oil. The daily average production in Feb. 1956 was 349 barrels of oil from 197 wells. The average gravity of the oil is 48°. Production is obtained from 4 main granite wash units of the [Permian] Pontotoc group (Wolfcampian) encountered between the depths of 1, 200 and 1, 600 ft. A fault terminates the field at the E. side. The Altus structure was a positive element until Hennessey (Clear Fork) time. --Auth.

1-2638. Markley, L.C. WEST FREDERICK FIELD, TILLMAN COUNTY, OKLAHOMA (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 180-186, 3 maps, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959).

The small but prolific West Frederick field is situated on an anticlinal trend which extends from the Frederick area in Tillman County, Oklahoma, to the Fargo producing area of Wilbarger County, Texas. Accumulation resulted from entrapment by anticlinal closure, although minor faulting exists. Oil is produced from the Canyon limestone [Pennsylvanian] and from Arbuckle dolomite [Ordovician]. In each of these carbonate reservoirs the porosity and permeability have been increased by weathering at an unconformity. --Auth.

1-2639. Atkinson, Walter E. SOUTH PALACINE FIELD, STEPHENS COUNTY, OKLAHOMA (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 187-197, 3 maps, 2 secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 6 refs.

The South Palacine field, located in Secs. 16, 21, 22, 23, 26, 27, 28, and 34, T. 2 S., R. 6 W., Stephens County, Oklahoma, was discovered in May 1949. Principal production comes from several sandstone zones in the Hoxbar sequence of upper Pennsylvanian age. Structurally the field is associated with the Wichita Mountains-Criner Hills trend of folding. The Hoxbar group of the Pennsylvanian system rests upon an eroded pre-Pennsylvanian surface, underlain by rocks of Ordovician age and older. Cumulative production to Dec. 1956 was 9, 104, 605 barrels of oil, with daily production at that time averaging about 1, 600 barrels. --Auth.

1-2640. Reedy, Harold J., and Howard A. Sykes. CARTER-KNOX OIL FIELD, GRADY AND STEPHENS COUNTIES, OKLAHOMA (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 198-219, 8 figs. incl. 3 maps, secs., log, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 5 refs.

The Carter-Knox oil field, located in the southeastern end of the Anadarko basin in southeastern Grady County and northeastern Stephens County, Oklahoma, covers an area of approximately 16.5 sq. mi., 1.5 mi. wide and 11 mi. long. The structure is a very steeply dipping, faulted anticline, which was first mapped on the surface in 1916. It produces from the rocks of the Permian system, and the Hoxbar, Deese, Springer, and Simpson groups. The first oil well was completed in 1923. Since the discovery of oil in the Permian, the field has undergone several drilling cycles, the latest being the development of gas-condensate production in the Simpson group which began with a Bromide sand discovery in 1956. As of Jan. 1958, the Carter-Knox field had produced a total of 33, 581, 015 barrels of oil, and on the same date was producing 3, 370 barrels of oil per day from 407 wells, from all zones. --Auth.

1-2641. Schweers, Fred P. MILROY FIELD, STEPHENS AND CARTER COUNTIES, OKLAHOMA (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 220-226, 4 maps, sec., graph, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 4 refs.

Discovered in 1917, the Milroy field comprises 2, 650 currently productive acres lying in the central-eastern portion of T. 2 S., R. 4 W., and extending into T. 2 S., R. 3 W. The Milroy structure is only slightly closed on the surface, but attains more than 2, 500 ft. of closure in the subsurface pre-Pennsylvanian strata. Its N. 65° W. axis parallels the Wichita-Criner-Hills anticlinorium. Production is derived from several horizons from the Permian down to the Ordovician, but the bulk of the 9, 187, 735 cumulative barrels of oil has been recovered from Pennsylvanian sandstones of Des Moinesian and Atokan age. --Auth.

1-2642. Parker, Everett C. STRUCTURE AND LITHOLOGY OF THE SPRINGER IN SOUTHEAST VELMA-CAMP AREA (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium... v. 2: p. 227-248, 21 figs. incl. illus., 3 maps, secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 2 refs.

Correlation of the several sandstone members of the Springer section [Pennsylvanian] has been done by use of the self-potential and resistance curves of the electric logs of the wells of the field. Examination of well cuttings has been useful in correlating the upper members of the Humphreys sandstone.

Delineation of these curves in 13 W.-E. cross sections shows local uniformity in the several sandstones of the Springer which can be considered due to consistent sedimentation, and also local variations and disappearance of the beds due to interrupted or variable sedimentation or to folding and faulting. These last 2 possibilities must depend upon the interpretation of the data in accordance with the general principles of sedimentary and structural geology.

The NW.-SE.-trending synclinal area between the major Milroy uplift to the SW. and the relatively minor Camp uplift to the NE. has on its SW. flank an involved series of serpentine folds in the supposedly incompetent Humphreys sandstone beds, which are shown to be continuous unless there is clear evidence of faulting. This is done to simplify the picture and does not assume that minor faulting and folding are not present.

The usefulness of this paper depends upon the wealth of data which deep drilling on 10-acre spacing has made available.--Auth.

1-2643. Walker, Keith F. WEST BROCK OIL FIELD, CARTER COUNTY, OKLAHOMA (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 249-261, 6 maps, 3 secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 2 refs.

The West Brock field, in southern Carter County, Oklahoma, was discovered by H.F. Gibson in Feb. 1947. To date practically all production has been from Pennsylvanian horizons. Oil is trapped in several closures against the S. side of E.-W.-trending normal faults. Oil is also found in lenticular sandstones at various positions on these structures.--Auth.

1-2644. Hale, G. Carl. SOUTHWEST ARDMORE FIELD (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 262-273, 3 maps, 3 secs., log, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 3 refs.

The Southwest Ardmore field [Oklahoma] is a N.-S. elongate anticline that plunges to the N. and S. It is adjacent to, and on the E. flank of, the Criner Hills and separated by a fault on the SW. which defines production. There is more than 1,400 ft. of structural relief, not including the faulted side of the field. The oil accumulation is probably due to a combination of structure and reservoir characteristics. Surface outcrops are confined to rocks of the Deese group [Pennsylvanian] and Viola limestone [Ordovician]. The field produces from sandstones and limestones in the Bromide, Tulip Creek, and McLish formations [Ordovician] at depths of 600 to 2,600 ft.--Auth.

1-2645. Gahring, Ross R. HISTORY AND DEVELOPMENT OF NORTH MADILL FIELD, MARSHALL COUNTY, OKLAHOMA (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 274-286, 4 maps, 2 secs., log Tulsa, Oklahoma, American Assocation of Petroleu Geologists, 1959) 3 refs.

The North Madill field is located in Secs. 9, 10, 14, 15, 16, 22, and 23, T. 5 S., R. 5 E., Marshall County, Oklahoma. Production is from the First, Second, and Third Bromide sands and the basal McLish sand of the Simpson group [Ordovician].

The structure is a thrust-faulted anticline with th production on the NE. or upthrow block. The date o this faulting and structural formation cannot be deter mined within narrow limits, but it is believed to be Pennsylvanian. The Comanchean beds on the surface rest unconformably on rock of lower Morrowan age and very slightly reflect the underlying structure.

The discovery well was started in Aug. 1954, and completed in Dec. 1954, producing from the basal McLish sand. As of Oct. 1, 1957, the field covered approximately 1,340 acres, with 69 producing wells. Total cumulative production to Oct. 1, 1957, was about 1,680,000 barrels. Development is continuing to the NW., NE., and SE.--Auth.

1-2646. Johnson, R.H., Jr. GEOLOGY OF MEDICINE SPRINGS AREA, PUSHMATAHA COUNTY, OKLAHOMA (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium.. v. 2: p. 287-301, 3 illus., map, 2 secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 19 refs.

The Jackfork formation [Pennsylvanian] was found to consist of about 5,800 ft. of tan and gray sandston interbedded with minor amounts of dark clay shale. Mapping was done on the basis of thin, persistent siliceous shales, the Maroon shale member of the Jackfork, and the Morrow faunal zone described by Honess from McCurtain County. More than 6,000 ft. of Atoka is exposed, but the top of this formation is not in evidence.

The trace of the Boktukola fault as seen on the sta geologic map was corrected. A new large thrust fault, the Cloudy fault, was mapped and named. The SE. half of the area consists essentially of a compressed syncline between these 2 faults. The NW. half forms the undisturbed S. flank of the Big One anticline.--Auth.

1-2647. Tomlinson, C.W. BEST EXPOSURES OF VARIOUS STRATA IN ARDMORE BASIN, 1957 (In: Ardmore Geological Society. Petroleum Geology of Southern Oklahoma, a Symposium...v. 2: p. 302-334, map, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959) 35 refs.

The Ardmore district [Oklahoma] displays a thick Paleozoic section, essentially complete from Upper Cambrian to lower Permian, with some older and younger rocks, all exposed in a small area of varied structure and remarkable orogenic history, though of modest topographic relief. For any geologist wishin a good general picture of North American geology, it is an indispensable area to see. Because of its exposures of scores of strata which produce oil within a few miles of these outcrops, it is an especially cla sic area for petroleum geologists. It is also much used by college classes for an introduction to field problems.

Higher mountains display such features more generously in the vertical dimension, but, correspondingly, more difficult footwork is likely to be require to see mountain exposures at close hand. Many of the critical exposures in the Ardmore area lie within a few yards of paved or all-weather roads. The best exposures of some members are hidden away in the woods or along creek beds, but nearly all are within a mile of a passable road, and accessible with a minimum of climbing.

Many visitors come to the district, desiring to see only certain parts of the section. Published maps give them a good general guide, but it is hoped that it will prove a convenience to visitors to have available also a list of the better outcrops of as many different rocks as possible, with precise locations and a few words of description of the terrain at each. The following list includes some 280 such outcrops, of 106 different stratigraphic units or rock types, and, also, 9 outcrops which illustrate especially well certain types of structure or episodes of orogenic history... A list of maps is appended for the benefit of those readers who may wish to check the areal and structural relations of the exposures described in this paper.--Auth. introd.

1-2648. Wagner, W.R. CATALOGUE OF DEEP WELL SAMPLES AND GEOPHYSICAL LOGS TO JANUARY 1, 1959: Pennsylvania Geol. Survey, Inf. Circ. 16, 84 p., fig., pl., 1959.

Prior to 1930, practically all drilling for oil and gas was restricted to the Upper Devonian or younger strata, but since the discovery of gas in the Lower Devonian Oriskany sandstone in 1930, 1,860 wells have penetrated through the Upper Devonian. This deeper drilling led to a classification of "shallow" and "deep" wells, the Tully limestone, the top of the Middle Devonian, being arbitrarily chosen as the dividing point. Wells either reaching or penetrating the Tully limestone are considered deep wells and those that stop in strata above the Tully are shallow wells; depth is not a criterion. This report deals only with the deep wells.

Wells in Pennsylvania having geophysical logs and/or samples are listed alphabetically by counties, and the counties are subdivided alphabetically by quadrangles. Each well has been assigned a quadrangle number which corresponds to the number used in the previously published reports of deep well records. The samples and geophysical logs of the out-of-state wells are also arranged alphabetically by counties, but are subdivided by townships rather than quadrangles.--Auth.

1-2649. Ergun, Sabri, James T. McCartney, and Morris Mentser. PHYSICAL AND CHEMICAL PROPERTIES OF THE PETROGRAPHIC COMPONENTS OF A HIGH VOLATILE BITUMINOUS COAL: Econ. Geology, v. 54, no. 6, p. 1068-1077, 2 graphs, 5 tables, Sept.-Oct. 1959, 39 refs.

Concentrates of the petrographic components of a high volatile A bituminous coal were obtained by centrifugal separation in salt solutions of adjusted specific gravity. Samples containing 94% vitrinite, 86% exinite, 87% micrinite, and 96% fusinite were obtained.

Various physical and chemical properties of the concentrates were determined, e.g., chemical composition, helium density, surface area, indices of refraction, and X-ray scattering intensities. The components were found to differ considerably in chemical composition and in most of the physical properties. Some of the physical properties could be related to chemical composition.--Auth.

14. ENGINEERING GEOLOGY

1-2650. Melhorn, Wilton N. GEOLOGY OF MACKINAC STRAITS IN RELATION TO MACKINAC BRIDGE: Jour. Geology, v. 67, no. 4, p. 403-416, 7 figs. incl. 3 maps (1 fold.), sec., chart, 2 tables, July 1959, 16 refs.

The construction of Mackinac Straits bridge has provided new data on the Paleozoic and Pleistocene history of the Mackinac region [Michigan]. The bedrock includes carbonates, chert, shale, and gypsum of late Silurian and middle Devonian age. Leaching of salt in the Pointe Aux Chenes (Upper Silurian) formation permitted the collapse of overlying rocks and produced the Mackinac breccia, but brecciation was not so intense or of such great magnitude as suggested in earlier studies. The breccia has been reconsolidated by loading under younger sedimentary rocks, recemented by secondary calcite, and perhaps additionally compacted by loading under glacial ice. The breccia has a bearing capacity considerably in excess of the load imposed by the bridge. Glacial deposits above bedrock are till and lacustrine clays of the Valders glacial substage, although older glacial deposits occur on the northern sides of the submerged Mackinac River gorge and a tributary channel. A buried sea stack encountered in probing indicates a level of only 152 ft. A.T. for the lowest water level of the Lake Chippewa-Lake Stanley low-water stage. No unusual construction problems were encountered during the removal of the glacial overburden or in the emplacement of the foundations on bedrock. Subsidiary problems of ice pressure and thrusting, wind, and currents are compensated for in the engineering design of the bridge.--Auth.

1-2651. Thompson, James R. PRELIMINARY GEOLOGIC SITE EXAMINATION IN WATERSHED PLANNING: Jour. Soil & Water Conserv., v. 14, no. 4, p. 156-159, illus., map, 4 secs., July 1959.

The over-all purpose of preliminary geologic examinations is to establish the geologic feasibility of structure sites, to provide a basis for planning detailed investigations, and to eliminate in the early stages of a watershed project as many uncertainties as possible.

It is important to review pertinent information about the watershed area in order to gain an appreciation of the broad geological aspects. From this, a summary of anticipated, specific geologic conditions can be made, and this will serve as a guide for intensity of field investigations. The results of preliminary geologic examination of Lick Creek watershed in eastern Tennessee is used to illustrate this. --Auth. summ.

1-2652. Gilluly, James, A.C. Waters, and A.O. Woodford. PRINCIPLES OF GEOLOGY: 2d ed., 534 p., illus., maps, secs., diags., graphs, tables, [San Francisco], W.H. Freeman and Company, 1959, refs.

A textbook for a first course in geology. The main stress is on physical geology, but one chapter is devoted to paleontology to show the interrelations between paleontology and stratigraphy. The book emphasizes geologic processes and the physical principles that are responsible for their operation. It also attempts to give the student some background for evaluating the basis (and also the intrinsic uncertainties) of geologic methods. Chapter headings are: introduction; minerals and matter; the record of the rocks; weathering and soils; erosion; geologic maps; strata, fossils and time; movements of the earth's crust; records of earth movements; gravity, isostasy, strength; downslope movements of soil and rock; stream erosion and deposition; glaciers and glaciation; ground water; deserts; the ocean; sedimentary rocks and the environments of deposition; igneous activity and metamorphism; earthquakes and the earth's interior; mountains; mineral resources. Appendices on maps, minerals, rocks, and earth chemistry are added. --Auth.

The first edition of this text was published in 1951. In the revision, attempts have been made to incorporate many of the significant advances in geology made during the last 7 years and to integrate the material into a more closely knit and teachable arrangement. All chapters have been rewritten and reorganized. Advances in knowledge of sedimentary rocks and their environments of deposition required the inclusion of a new chapter and the expansion of material on strata, fossils, and time into a full chapter. Sections on metamorphic rocks and metamorphic processes have also been reorganized and expanded. --From auth. pref. to 1st and 2d eds.

1-2653. Schlicker, Herbert G. BIBLIOGRAPHY OF THESES ON OREGON GEOLOGY: Oregon, Dept. Geology & Mineral Industries, Misc. Paper no. 7, 14 p., map scale 1:1,000,000, 1959.

This bibliography is intended to provide ready information concerning theses dealing with Oregon's geology. Information for this compilation was obtained by contacting 52 selected colleges and universities thought to represent more than 90% of the graduate studies of the state. The bibliography contains 191 entries. The index map locates specific areas described in the theses. --Auth.

1-2654. Shabanova, A.I. ON THE ACCURACY OF SMALL-SCALE MAPS. Prepared by the United States Joint Publications Research Service: Internat. Geology Rev., v. 1, no. 8, p. 73-78, 4 tables, Aug. 1959.

Errors on the order of ± 0.5 mm. are introduced in the compilation, preparation, printing, and mounting of small-scale maps. Approximately 70% of the error occurs in compilation; only 15% in printing and mounting. Mean square errors are approximately the same for maps compiled by the method of copying squares and for those compiled from blueline prints. The accuracy of plotting rivers and roads is somewhat higher than the accuracy of compiling populated places, elevation points, and wells. Technological improvements apparently should be sought for the mechanization of compilation and substitution of blu line paper by another material less subject to distor tion. --G. E. Denegar.

1-2655. Miller, Robert D., and Dwight R. Crandell TIME-LAPSE MOTION PICTURE TECHNIQUE APPLIED TO THE STUDY OF GEOLOGICAL PROCESSES: Science, v. 130, no. 3378, p. 795-796, 2 illus Sept. 25, 1959.

Light-weight, battery-operated timers were built and coupled to 16-mm. motion-picture cameras hav ing apertures controlled by photoelectric cells. The cameras were placed adjacent to Emmons Glacier o Mount Ranier. The film obtained confirms the view that exterior time-lapse photography can be applied to the study of slow-acting geologic processes. --Auth.

1-2656. OCEAN BOTTOM PHOTOGRAPHY: Naval Research Rev., p. 14-25, 27 illus., July 1959.

Twenty-seven photographs of or concerning under water photography include signs of activity on the ocean bottom, a pycnogonid, brittle stars, mud bottoms, evidence of deep-water erosion, Mn nodules, stereoscopic views, a luminescence camera, and an acoustical view finder. --M. Russell.

1-2657. Hamelin, Louis Edmond. LA COMMISSION INTERNATIONALE DE GÉOMORPHOLOGIE [SIC] PÉRIGLACIAIRE ET LE CANADA [THE INTERNATIONAL COMMISSION ON PERIGLACIAL MORPHOL OGY AND CANADA]: Can. Geographer, no. 13, p. 1 16, 1959, 15 refs., text in French, abs. in English.

The I.G.U. Commission on Periglacial Morpholog was set up in 1949, and its first report was presente to the 17th Congress in Washington in 1952. Between 1952 and 1956, the Commission published a select bibliography on periglacial phenomena, and a few national maps were produced. A short study on Can dian periglacial morphology appears in the general report to the 18th Congress in Rio de Janeiro in 1956 From that date Canada has been represented on the Commission, which has met in Spain and Poland. During 1959, a national map of Canadian periglacial phenomena will be prepared for presentation at the 19th Congress in Stockholm in 1960. --Auth.

1-2658. Romer, Alfred S. CENTENNIAL OF THE "AGASSIZ MUSEUM": Harvard Found. Adv. Study & Research, Newsletter, p. 3-6, Sept. 30, 1959.

Although the Museum of Comparative Zoology, more commonly called the Agassiz Museum, at Har vard University is primarily an institution for biological research, it has always been interested in geology, most notably in stratigraphy, sedimentatio and paleontology. It was founded in 1859 with $50, 0 bequeathed by an admirer of Louis Agassiz, the Museum's first director. Succeeding directors wer Alexander Agassiz, Samuel Henshaw, Thomas Barbour, and Alfred S. Romer. The Museum staff annually publishes about 3,000 pages of research mate rial, its library consists of about 250,000 volumes zoology and certain aspects of geology, and it has the third most valuable research collection in the United States. The Museum is the outstanding university center in paleontology in this country, and possibly in the world. --M. Russell.

1-2659. Van Alstine, Ralph E. RESULTS OF 1959 NATIONWIDE GEOLOGY EXAMINATION OFFERED BY UNITED STATES CIVIL SERVICE COMMISSION: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 9, p. 2243-2244, 2 graphs, Sept. 1959.

This examination, consisting of 100 multiple-choice questions, was taken on Jan. 12, 1959, by 1,918 people - twice as many as in recent years. Although about 27% passed the exam in the past 13-year period, only 15% (289) passed the 1959 examination. Of those that passed, 214 or 74% had some graduate training; college seniors constituted 55 of the remaining 75. Further information about the distribution of students in colleges throughout the country is given. A new provision enabled 24 students who showed superior achievement on the exam and in college to be given GS-7 ratings. --L. M. Dane.

1-2660. Proctor, Paul Dean. INDUSTRY AND GEOLOGICAL AGENCIES EVALUATE A CURRICULUM IN GEOLOGY: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 9, p. 2228-2237, 6 tables, Sept. 1959, 16 refs.

The Missouri School of Mines and Metallurgy sought an evaluation of the Bachelor of Science in geology by sending questionnaires to employers in industry, geological surveys, consulting geology and geophysics. The study, made in 1958, was designed to test the adequacy of the basic requirements for the degree, to obtain suggestions for revisions in the curriculum, and to receive any constructive comments pertaining to the training of students. Of the 105 questionnaires distributed, 85 were completed and used in this study.

Need for greater emphasis on fundamental training in the basic sciences (chemistry, mathematics, and physics) is apparent. "The data and letters indicate the desirability of a core curriculum of basic science and geology requirements. A minor division into petroleum and general geology at the undergraduate level, with the general geology subdivision including the needs of mining industry and geological surveys, would closely fit the evaluation pattern." --L. M. Dane.

1-2661. Gould, Charles N. COVERED WAGON GEOLOGIST: 282 p., 16 illus., 2 maps, Norman, Oklahoma, University of Oklahoma Press, 1959.

Autobiographical account of the life and work of Charles N. Gould, published posthumously. Gould was raised in southwestern Kansas and became interested in geology through the influence of L. C. Wooster, S. W. Williston, and Lester F. Ward. In 1901 he became the first teacher of geology at the University of Oklahoma and was geologist on the Oklahoma Territorial Survey and the U.S. Geological Survey. He was the first State Geologist of Oklahoma (1908-1911). Gould was in the oil business from 1911 to 1924, at which time he was again appointed State Geologist of Oklahoma, in which capacity he served until 1931. For seven years (1935-1942) he was geologist with the National Park Service and wrote 251 reports on geology of national parks and monuments. --C. C. Branson.

1-2662. U.S. Chamber of Commerce. CONSERVATION AND USE OF NATURAL RESOURCES - 1959-60 POLICY DECLARATIONS: 53 p., 16 illus., Washington D.C., [1959?] 22 refs.

Basic principles of conservation are set forth to further the orderly and economic development of our natural resources. Intelligent use of these resources without greed or emotionalism is stressed. Contained in this booklet are policy declarations relating to problems and issues in the following fields: federal lands, forestry, mining, petroleum, recreation, mapping, water resources, and weather modification. A discussion of related policies is also included. --L. M. Dane.

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